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A PROGRESS REPORT on RESEARCH with BEEF CATTLE at the FRONT ROYAL STATION

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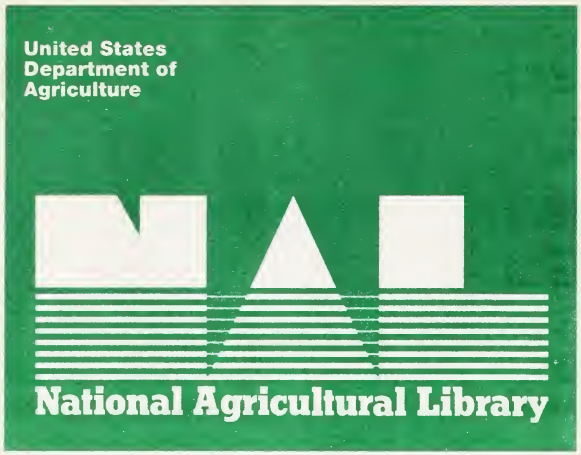
October 1962

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
and
VIRGINIA AGRICULTURAL EXPERIMENT STATION
Virginia Polytechnic Institute
Cooperating



Current leaders of the research project are: B. M. Priode, USDA, and K. P. Bovard, VPI, Front Royal, Va.; R. C. Carter and G. W. Litton, VPI, Blacksburg, Va.; R. S. Temple, USDA, Knoxville, Tenn.; and, E. J. Warwick, USDA, Beltsville, Md.

Former project leaders, currently engaged in other work, or deceased*, include: R. L. Arthaud, A. L. Baker*, W. H. Black*, M. J. Burris, and C. M. Kincaid.

ACKNOWLEDGMENT

The advice and assistance of W. R. Harvey and the staff of the Livestock Section of Biometrical Services, AHRD, USDA, Beltsville, Md. in the statistical analyses of these data are acknowledged.

A portion of the 4,160 acres and some of the permanent buildings at the Reef Cattle Research Station. In 1948, the property was transferred to the U. S. Department of Agriculture from the Department of Army by Act of Congress, Public Law 494. The purpose of this act was "to best advance the livestock and agricultural interest of the United States."

A PROGRESS REPORT ON

RESEARCH WITH BEEF CATTLE

AT THE FRONT ROYAL STATION

K. P. Bovard and B. M. Priode

INTRODUCTION

Research has played an increasingly important role in the progress made during the past few decades in nearly every area of human interest -- space exploration, medicine, and agriculture, to name a few. Since the late 1940's a coordinated nationwide program of controlled experiments dealing with breeding of beef cattle has been conducted. The following report presents a summary of results from one part of this study which since 1949 has been in progress at the Beef Cattle Research Station, Front Royal, Virginia.

HISTORY AND FACILITIES

Administration

In 1946 Congress approved the "Research and Marketing Act" providing for regional research of a cooperative State-Federal nature on agricultural problems of importance at more than one state. To administer the research program under this act, the country was divided into four geographical regions, namely: Northeast, Southern, North Central, and Western. Beef cattle breeding projects were developed in each region except the Northeast.

Since the Front Royal station is ideally situated for beef cattle breeding research it was decided to direct its activities largely to this purpose. The United States Department of Agriculture invited the Virginia Agricultural Experiment Station to become a partner in the program. It has been operated cooperatively since 1949 as part of the Southern Regional Beef Cattle Breeding Project, S-10, and the national program. Personnel of both agencies are located at Front Royal, where the research program is jointly planned, supervised, and financially supported.

Land

Beginning in 1909 the total land area was acquired through the purchase of small farmsteads. It was used as an Army Remount Station until 1948. During its tenure by the Army, the land was used mainly for the

Existing reminders of former Army Remount days: Tom, an Army mule, transferred to Agriculture and still in active service and (right) a portion of the horse graveyard.

breeding and training of cavalry horses, the number of animals varying between a few hundred and 8,000. The maximum number was reached during World War II when the station was used as a receiving center, processing horses en route to other military units, many overseas. During World War II, the station was also active as a prisoner of war camp and as a training site for dogs used in the K-9 Corps.

Pasture

About two-thirds (2,600 acres) of the station property offers good grazing for cattle, most of the remainder is wooded. Permanent pastures are primarily orchard grass, blue grass, and white clover. Their carrying capacity is approximately 3 to 4 acres per animal unit, although this varies with seasonal rainfall.

There are approximately 90 miles of fence on the station. Cross fences divide the grazing area into 30 breeding pastures, each with carrying capacity of 15-25 cattle.

Farm Operation

Approximately 240 acres of the station property are used for production of hay and grass silage. Second, or later cuttings of these crops are usually grazed. Sufficient hay, corn and grass silage, and grain are produced from the total farm enterprise to meet most requirements of the experimental cattle for roughage and grain. Protein supplement is purchased.

Concrete fence posts with three wooden rails were used by the Remount Service; to use the same fence lines for cattle, woven wire was added.

In addition to station property, 130 acres of river bottom land west of Front Royal are leased.

A grinding and mixing feed mill, 1½ ton capacity, installed in the former granary in 1956, makes possible the preparation and processing of all rations for the cattle on tests.

Buildings

In 1948, there were 157 buildings included in the original property transfer. Currently, 37 of these are used by other government agencies, 22 have been salvaged, 31 barns and feeding sheds are in use, 15 residences are occupied by station personnel and their families, and 52 other buildings are used for storage, repair, and maintenance of equipment. Conversion of many of these facilities from horse to cattle use has required much effort and expense.

Cattle Handling Facilities

The total grazing area is divided in two nearly equal parts by U. S. Highway #522. Located in each of these areas is a large corral, several pens, a chute, head catch, and scale where much of the routine handling of animals is done. In the spring of 1959 nine additional catch pens were constructed in strategic pastures to facilitate the artificial breeding of all cattle. These have simplified other routine handling requirements, such as grading, spraying, and branding.

Facilities, including lots, shelters, and scales, for conducting annual postweaning tests for about 50 bulls are located in one area, and for about 85-130 heifers and 25-50 steers in another area.

RESEARCH PROGRAM

Purpose

Basically, the purpose of any experiment is to obtain new information, and this is true of the Front Royal project with beef cattle. The information primarily being sought deals with methods of producing genetic improvement in characteristics of economic importance -- for example, growth rate and conformation.

A grassland agriculture is basic to the Appalachian region, and good grass -- pasture, hay, and silage -- is a basic requirement for beef production. One of the primary objectives of the Front Royal (and the Southern Regional) program, therefore, is the development of methods for improving cattle well adapted to roughage consumption. Information obtained under these management conditions makes results more meaningful to those who will subsequently use them.

Scope of Work

Experimental Plan

The stated objectives of the Front Royal project include (1) estimation of progress from mass selection with that from family selection, (2) evaluation and improvement of available criteria, and (3) the simplification of progeny- and sib-testing procedures to permit earlier identification of superior animals.

Studies of progress from selection and studies with inbred lines of beef cattle have been, and are being, conducted at other experiment stations, but the design of the Front Royal experiment, permitting simultaneous comparison of both systems from a common genetic base, is unique. The plan, illustrated in figure 1 is the same in each of the three British breeds -- Angus, Hereford, and Shorthorn -- maintained for experimental study.

In each breed, four foundation sires were chosen after completing superior performance tests, progeny tests, or both. From a set of 32 daughters by each foundation bull, 16 are chosen at random, bred back to their sire, and thereafter remain as the original stock in the inbred line. Male and female replacements for the inbred lines are chosen for net merit (based on growth and type) from within the line. An additional eight daughters by each foundation sire are chosen at random and assigned permanently to a type selection herd; the remaining eight are assigned to a growth selection herd. This plan in each breed (see figure 1) provides four inbred lines of 16 cows each, and two selection herds of 32 cows, each. In addition, plans for the Hereford breed include an additional selection herd to be selected for both growth and type.

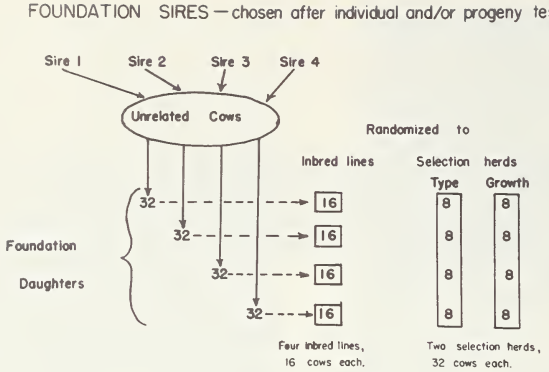


Figure 1. A schematic diagram showing how the permanent lines of breeding were established for each breed—Angus, Hereford, and Shorthorn. In addition, an index (type and growth) selection herd of 32 cows was established in the Hereford breed, thus requiring 40 daughters by each Hereford foundation sire.

Following a practice much like that of the average breeder, female replacements come from within each selection herd; males may come from any of the lines or herds kept at Front Royal, or from outside breeders. This latter possibility permits annual comparison of calves from inbred lines and from selection herds with cattle from outside breeders' herds. Each year approximately four calves of each breed are purchased at weaning age from outside breeders and entered in competition with the Front Royal calves in the postweaning record-of-performance (ROP) test. Bulls used in the selection herds in previous years have come from each source.

Prior to 1958, Angus and Shorthorn selection herds contained fewer than 25 breeding females and were handled as single-sire units, one new sire used each year. Since 1958, two sires -- a yearling chosen at the conclusion of each year's ROP test, and a two-year-old retained since the previous year -- have been used to breed the 32-40 females carried in each selection herd. Cows are randomized each year to the two sires used in their respective herds.

Hereford selection herds were initially operative in 1961, also managed in 1962, as single-sire units. They will each be two-sire herds managed exactly like those of the Angus and Shorthorn breeds beginning in 1963.

In each selection herd, replacements of both sexes are chosen primarily on the criterion for which the herd is being selected -- that is, either type or growth. As shown in later sections, some interesting results have been found in comparisons among the selection herds and the inbred lines.

Selection Studies

One breeding method under investigation at Front Royal is that of selection. Individual selection is commonly practiced by most breeders in mating the best bull available from any source to the cows kept after culling. When the decision to keep or cull an animal is further influenced by the performance of its relatives -- ancestors, progeny, or both -- a form of family selection is being practiced. Individual and family selection have been, and continue to be, the most common breeding methods used for effecting genetic improvement of domestic animals.

Inbreeding

Inbreeding -- the mating of relatives -- is another breeding method being studied at Front Royal. It was practiced in the early stages of the formation of most breeds of domestic animals. Its capacity to "purify" a stock and fix certain characteristics in a line or strain was recognized long before Mendel's studies of peas in the 1850's, from which the science of genetics grew.

Following the rediscovery of Mendel's work in 1900, studies of inbreeding in plants led to the development of hybrid seed corn produced by crosses of two or more inbred lines. Experimental results showed, generally, that hybrid corn was superior to that produced from selected open-pollinated varieties (i.e., those improved by selection alone). In recent years strains of "hybrid" chicks and pigs have been offered for commercial production. Similar possibilities have not been adequately investigated experimentally with cattle.

Non-genetic Studies

In order to more fully utilize the cattle in research herds, short-term studies of a non-genetic nature are conducted whenever possible. For

example, different rations, methods of feeding, and methods of handling cattle have been compared when there is good assurance that factors in the short-term study will not affect the comparisons pertinent to the long-term genetic experiment. Some of these studies are described in a later section.

Liaison with USDA and VPI

Laboratory facilities at Beltsville, Maryland and at Blacksburg, Virginia meet with extensive use in cooperative studies conducted at the Front Royal Station.

For certain special problems, animal scientists from the Beltsville, Maryland Station (USDA), about 90 miles distant, have frequently studied groups of cattle at Front Royal, particularly in cases where large numbers treated alike were required. Studies of reproductive performance, of rumen contents, and of some diseases are examples.

Similar cooperative studies have been conducted with personnel of the Animal Husbandry and other departments of the Virginia Polytechnic Institute (VPI) at Blacksburg. In addition, graduate and advanced undergraduate students from VPI have collected, analyzed, and interpreted data for theses and special reports. This relationship offers the student an opportunity to acquaint himself with some of the various, often unexpected, questions which inevitably arise during the course of almost every experiment. It extends the student's background and experience, and frequently suggests special problems which may be investigated after minor changes have been made in certain experimental procedures. It also provides an important element of mutual stimulus between the student and the project leaders, affording a still broader base from which the program may continue to develop.

Evaluation of Inbred Lines

An inbred line's relative value is measured by the performance of its topcross and linecross progeny in comparisons with similar test progenies of other inbred lines. This phase of the inbreeding studies now in progress at Front Royal has only recently begun on a limited scale through a testing program conducted cooperatively with three Virginia correctional institutions.

At each cooperating institution a beef herd of 40-120 cows is maintained primarily as a source of beef for inmates. Since 1959, sixteen bulls, eleven by foundation sires, have been loaned to these institutions where routine calf performance data from birth to weaning are obtained. At each location cows are randomized to breeding groups each year, thereby permitting comparisons among sires -- those from Front Royal as well as from other sources -- on the basis of their progeny performance.

A testing program is necessary for a comprehensive evaluation of the several inbred lines being developed, but could not possibly be conducted, even in its present limited scope, at the Front Royal station. This sort of cooperative testing program makes it possible to obtain essential additional information and thereby more reliably estimate breeding values of the several inbred lines studied.

Cattle

In early years of operation available funds did not permit purchasing all cattle needs. Cattle currently in the experimental herds were derived as follows. Approximately 125 head of Shorthorn cattle were transferred from the Beltsville station to Front Royal in 1949. During the early 1950's a number of cattle were transferred from the Blacksburg station to Front Royal. Several Angus and Hereford cattle were purchased by the U. S. Department of Agriculture and by the Virginia station. Cattle numbers were also increased by maintaining breeder-owned cow herds on the station on a share basis, these cows being used to progeny test bulls. Calf crops were divided equally, the station's share helping to build foundation herds.

Several young bull calves were first given routine record-of-performance (ROP) tests, then later were progeny-tested. A complete list of the 153 bulls (50 Angus, 50 Hereford, and 53 Shorthorn) used in breeding herds appears in appendices I-III. Most of the foundation sires (see figure 1) were chosen by 1956. The detection of Snorter dwarfism in two foundation sets of Hereford cattle in the middle '50's delayed the selection of the fourth and final foundation sire until 1960. A more complete description of foundation sires used in the project appears below.

Part of the original Shorthorn cow herd transferred in February, 1949 from the Agricultural Research Center, Beltsville, Maryland.

Cattle of similar sex and age are handled as nearly alike as is possible, with most feeding and management practices similar to those of commercial beef producers of the Appalachian region. Females beyond one year of age are maintained primarily on roughage (i.e., pasture, hay, or silage) throughout the year, receiving limited protein supplement through the winter feeding period from December 1 until April 15.

The number of cattle in the research program was 865 on July 1, 1962. Table 1 shows proposed numbers of animals by breed, sex and age at December 1 each year when all phases of the program are in full operation.

TABLE 1. PROPOSED CATTLE INVENTORY - DECEMBER 1 OF EACH YEAR

	Females			Bulls			
Breed	Bred Cows and Heifers	Calves	Steer Calves	Mature	Year-lings	Calves	Total
Angus	146	50	24	6	2	20	248
Hereford	182	65	30	7	3	24	311
Shorthorn	146	50	24	6	2	20	248
Total	474	165	78	19	7	64	807

FOUNDATION SIRES

Foundation sires were chosen by the project leaders. They based their choices primarily on progeny performance, although superior individual performance was often a prerequisite to being progeny tested.

A committee composed of the project leaders, and other persons designated by the two cooperating agencies, was given authority to purchase bulls of any age from any available source. Selection standards of the committee emphasized growth rate and conformation, although members were free to choose any calf or calves considered desirable by all committee members.

In the beginning, yearling or older bulls were first progeny tested as foundation prospects. After 1952, however, most prospects were first placed on routine postweaning tests. At the conclusion of each year's test, the committee agreed upon candidates whose performance records were sufficiently outstanding to merit progeny testing. Two years after being first chosen for progeny testing, candidates had several yearling progeny from which routine performance data had been obtained. In some cases, final selection of a foundation sire by the committee was based on more than one year's calf crop. Thus, nearly all foundation sires were at least three years old, a few more than five years old, when they were chosen for permanent use in the breeding experiment.

The pedigree and remarks pertinent to the background of each foundation sire appear below. Individual performance records are also presented for sires tested at Front Royal. Terms are defined as:

$$\text{Pretest gain} = \frac{\text{Beginning test weight - birth weight,}}{\text{Age in days on first day of test}}$$

$$\text{ROP gain} = \frac{\text{Ending test weight - beginning test weight,}}{\text{Days on test}}$$

$$\text{Total daily gain} = \frac{\text{Pretest gain + ROP gain, and,}}{2}$$

Yearling type score is calculated using the numerical code described on page 25.

For progeny of each sire used since 1950 in foundation, selection or test herds at Front Royal, the number and average performance from birth to weaning are presented in appendices IV-VI. Similar data on postweaning performance appear by lines, but not by sires, in appendices VII-IX.

For convenience in reference and in data processing, the name of the inbred line headed by each foundation sire has been shortened to one or two words. Each line was also assigned a number according to the chronological order in which the foundation sires of each breed were chosen.

KB EILEENMERE 21 1103554

Born May 6, 1948
Tattoo: 59

Bred by C. T. Edwards
Kingsport, Tenn.

Eileenmere 2631 812285	Eileenmere 487 668743	Eileenmere 85 470007	Eileenmere 32 428072	
			Enchantrene 364519	
		Pauline T 6 523013	Eileenmere 32 428072	
			Pauline T 4 363531	
	Pridemere T 46 722437	Eileenmere 85 470007	Eileenmere 32 428072	
			Enchantrene 364519	
		Pridemere T 6 470011	Eileenmere 32 428072	
			Pride of Rosemere 157 414186	
Ballestamere 723678	Eileenmere 249 551725	Eileenmere 140 494252	Eileenmere 32 428072	
			Blackcap Missie 380118	
		Blackberry 55 453473	Eileenmere 32 428072	
			Blackberry Elmose 367490	
	Ballesta T 2 522976	Ballerna's Lad 402990	Enchanteau 323206	
			Ballerna 323205	
		Ballesta 396104	Blackbird's Baribas 244853	
			La Vita Blackbird 297395	

KB Eileenmere 21 was first used at Front Royal in 1950, later used at the Northern Virginia Pasture Research Station, Middleburg, then returned to Front Royal for use as a foundation sire. The bull died in September 1958.

Eight sons, four non-inbred, have been used in his inbred line, with year or years of service shown in appendix I. They were: TFB Eileenmere of FR 4 (#171), M Eileenmere 2 (#161), Eileenmere of FR 5 (#870), Royal Eileenmere of FR (#917), FR Eileenmere 1166, FR Eileenmere 198, FR Mr. Eileenmere 8184, and FR Eileenmere 1575.

Five sons or grandsons of this foundation sire have been used in the selection herds: two were inbred, three non-inbred. They were: Sir Eileenmere of FR (1019), type bull in 1955; FR Mr. Eileenmere 8184, type 1959-60, Sir Eileenmere of FR 4 (1046), growth 1955; FR Eileenmere 1390, growth 1958; and FR Eileenmere 1575, growth 1962-63.

FR Eileenmere 1166 and FR Mr. Eileenmere 8184, sons of KB Eileenmere 21.

ROCK DELUS 1404534

Born December 9, 1950
Tattoo: 057

Bred by C. T. Neale
Gordonsville, Va.

- Rock Enammus 632223
  - Evaxus 8 of Page 445115
    - Evaxus of Ballindalloch 428984
      - Jorum of Ballindalloch 423476
      - Evilexa of Ballindalloch 428927
    - Miss Burgess 3 of Nisbethill 349404
      - Edgar of Harviestoun 349395
      - Miss Burgess of Nisbethill 349397
  - Enamma 24 of Sunbeam 507381
    - Black Peer of St. Albans 456385
      - Eric Revolution 404801
      - Blackcap Glencarnoch 8 438140
    - Enamma 11 of Sunbeam 450709
      - Elban of Sunbeam 401496
      - Enamma of Sunbeam 5 389611
- Delia of Rocklands 672780
  - Elba Bandolier of Anoka 540738
    - Blackbird Bandolier of Page 414212
      - Glencarnock Revolution 6 384963
      - Blackbird Harrison 6 387977
    - Ebonessa of Don Head 540736
      - Ethric of Nisbethill 504390
      - Ebina of Nether Mains 540735
  - Elenor 9 561167
    - Bandolier of Anoka 5 481194
      - Blckbird Bandolier of Page 414212
      - Barbara Rose of Anoka 481188
    - Elenor 5 469290
      - Revolution 91 423971
      - Elnora J 3 417983

Rock Delus was used from 1952 through 1961 except in 1955, when used at the Middleburg Station.

As a weanling calf in 1951, his ROP data were: pre-test gain, 1.87; age on test, 312; number days on test, 168; beginning weight, 648 ; ending weight, 1020; ROP gain, 2.21; yearling type score, 14.2; and, total daily gain, 2.04.

An inbred son, FR Rock Delus 218, was first used in 1961 and now heads the A-2 line.

BLACKCAP STAMP OF ELKTON 2 1304552

Born May 4, 1950
Tattoo: 420

Bred by Old Elkton Farms
Forest, Virginia

- Epponian Stamp of Broadview 607618
  - Epponian of Rosemere 8 478362
    - Eileenmere 61 450556
      - Eileenmere 32
      - Ectessa
    - Epponia C B 2 452209
      - Prizemere 32
      - Epponia C B
  - Blackcap 23 of Page 482971
    - General of Page 452594
      - Revolution of Page 11
      - Genevette of Ballin.
    - Blackcap C B 15 326312
      - Meraman of Terra Alta
      - Blackcap 52
- Blackcap Bessie 12 542324
  - Enechoes Revelation 498249
    - Evergreen Revelation 466745
      - Revelation 9
      - Evergreen Elna
    - Enecho R 430152
      - Revolution 12
      - Enecho 17
  - Blackcap Bessie 5 425909
    - Elvan 2 374905
      - Elzevin
      - Eblina 5
    - Blackcap Lassie 23 330853
      - Bravo of Denison
      - Blackcap Lassie 5

Blackcap Stamp of Elkton 2 was used through 1959, apparently sterile thereafter, and was slaughtered in March 1960.

This bull's postweaning performance data were: pre-test gain, 2:35; age on test, 167; number days on test, 168; beginning weight, 457; ending weight, 882; ROP gain, 2.56; yearling type, 13.8; and total daily gain, 2.46.

An inbred son, FR Blackcap Stamp 8150, was used in this line in 1960 and 1961; his son FR Blackcap Stamp 1552, now heads the line.

Three non-inbred sons of the foundation sire, Blackcap Stamp of Elkton 2, were used in the growth herd: in 1957, FR Blackcap Stamp 1209; in 1958 FR Blackcap Stamp 1293, whose maternal great grandsire was KB Eileenmere 21 (A-1 foundation); and in 1959-60, FR Blackcap Stamp 8044.

Shown at weaning (above), and at a year (right) is FR Blackcap Stamp 1552, a 19% inbred grandson of Blackcap Stamp of Elkton 2, first used in the A-3 line in 1962. This calf's total daily gain was 2.36, his yearling type score 13.5.

BLACKWOOD BANDY OF FR 4 1560476

Born March 4, 1952
Tattoo: 890

Bred by Beef Cattle Research Station
Front Royal, Virginia

Blackwood Bandy of Amandale 1267658	Amandale's Bandolier 9 1037404	Wintonian 5 567767	Enfileen's Bandolier 2 510436
			Queen of Rosemere 244 486591
		Canterbury Blue Lady 4 602642	Briarcliff Envidon 463303
			Briarcliff Blue Lady 7 460140
	Amandale's Blackwood Lady 925035	Wintonian 5 567767	Enfileen's Bandolier 2 510436
			Queen of Rosemere 244 486591
		Bethel Blackbird 37 743612	Bethel Elinolier 575016
			Briarcliff Blackbird 53 442973
Bending River Evocate 990199	Epponian's Pal of LeBaron 796361	Epponian 5 of LeBaron 596452	Epponian Rosemere 8 478362
			Buxom Maid 5 of Page 493676
		Eccota 32 591325	Eugenexor 591310
			Eccota 30 591300
	Innisfree Alta 15 592666	Black Quality Marshall 450658	Quality Marshall 369886
			Blackbird Venus 378015
		Evocate Evidence 6 592644	Bar Henderson 530841
			Evocate Evidence 3 592631

Blackwood Bandy is the only foundation sire bred and raised at Front Royal. The son of a test bull, he was used naturally from 1954 through 1958, used artificially in 1959 and 1960, and is currently on loan to the Virginia Artificial Breeding Association, Rocky Mount.

His ROP results were: pre-test gain, 2.03; age on test, 227; number days on test, 167; beginning weight, 531; ending weight, 932; ROP gain, 2.40; yearling type score, 13.0; and total daily gain, 2.22.

His inbred son, FR Wintonian 210 has been used in the A-4 line since 1961.

Two non-inbred sons have been used in the type herd: FR Wintonian Lad 1081, in 1956, and FR Wintonian Lad 1165, in 1957.

Shorthorn cattle originally transferred from the Beltsville station in 1949 included two more or less distinct lines of breeding in which mild inbreeding had already been practiced. One of these lines dated back to 1930 when Sni-A-Bar Type 1637061 was brought into the Beltsville herd for use on Vint Hill Challenger cows; the other line dated to December 1933 when two cows and two bulls, all sired by the imported bull, Calrossie Lord Rothes, were brought into the herd. In 1949 there were on hand several groups of half-sibs by different sires and related to one or the other of the two sires mentioned previously. Two sets of foundation females were therefore drawn from the Shorthorn herd, with 32 cows in each set. These two sets of 32 females were then handled as a conventional set of foundation daughters, being randomized to inbred, type, and growth herds.

S-1 Statesman

WAVERLEY'S STATESMAN 2291825

Born March 12, 1945
Tattoo: 552

Bred by United States Department of Agriculture
Beltsville, Maryland

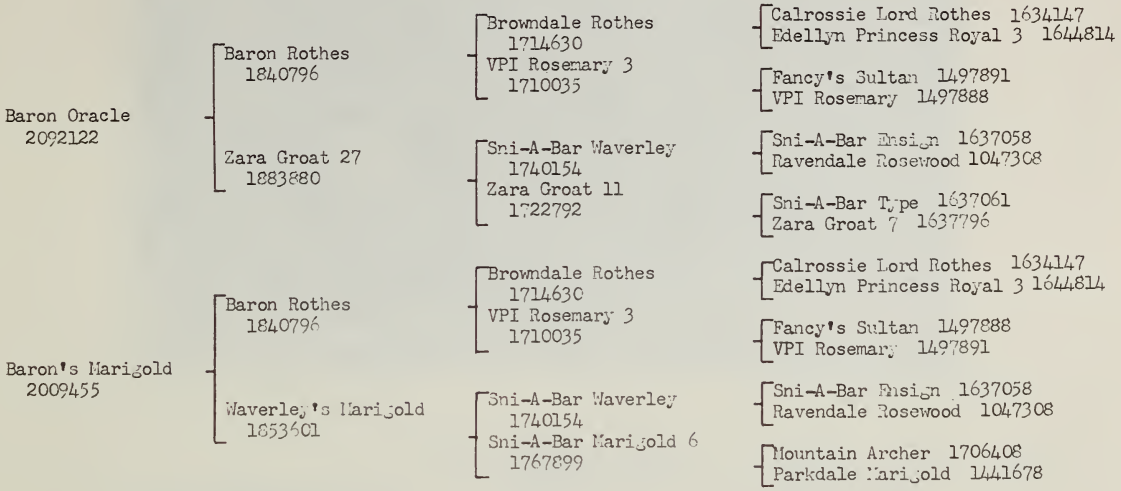
<table>
<tr><td rowspan="8">Waverley's Warrior 2004777</td><td rowspan="4">Waverley's Type 1917318</td><td rowspan="2">Sni-A-Bar Waverley 1740154</td><td>Sni-A-Bar Ensign</td></tr>
<tr><td>Ravendale Rosewood</td></tr>
<tr><td rowspan="2">Zara Groat 11 1722792</td><td>Sni-A-Bar Type</td></tr>
<tr><td>Zara Groat 7</td></tr>
<tr><td rowspan="4">Zara Groat 31 1907354</td><td rowspan="2">Sni-A-Bar Type 1637061</td><td>Saltoun Claymour</td></tr>
<tr><td>Matchless Marchesa 3</td></tr>
<tr><td rowspan="2">Zara Groat 6 1637797</td><td>Vint Hill Challenger</td></tr>
<tr><td>Zara Groat</td></tr>
<tr><td rowspan="8">Zara Groat 35 1947036</td><td rowspan="4">Sni-A-Bar Waverley 1740154</td><td rowspan="2">Sni-A-Bar Ensign 1637058</td><td>Saltoun Claymore</td></tr>
<tr><td>Augusta Supreme</td></tr>
<tr><td rowspan="2">Ravendale Rosewood 1047308</td><td>Glaryford Augustus</td></tr>
<tr><td>Rosewood 93</td></tr>
<tr><td rowspan="4">Zara Groat 11 1722792</td><td rowspan="2">Sni-A-Bar Type 1637061</td><td>Saltoun Claymore</td></tr>
<tr><td>Matchless Marchesa 3</td></tr>
<tr><td rowspan="2">Zara Groat 7 1637796</td><td>Vint Hill Challenger</td></tr>
<tr><td>Zara Groat 4</td></tr>
</table>

Waverley's Statesman 2291825 was transferred from Beltsville to Front Royal in 1949, designated the foundation sire for the Statesman line on the basis of his individual and progeny performance records, and used through 1951. He was also used in the growth herd in 1950. His son, B-P Statesman of FR 4 (#868) was used in 1952. Since 1953, another son, C Statesman of FR 4 (#885) has produced all calves in the Statesman line but 7 born in 1962 by FR Statesman A 211, a son of C Statesman of FR 4.

BARON KINSMAN 2458011

Born July 2, 1947
Tattoo: 663

Bred by United States Department of Agriculture
Beltsville, Maryland



Baron Kinsman was first used as a replacement for Baron Justice (#671) at the end of the 1950 breeding season and continued as head of that line until 1956, when replaced by a son, FR Baron B 1176, who was, in turn, replaced in 1959 by his son, FR Baron B 1392, the sire currently heading the S-2 line.

GRASSDALE LEADER 2537106

Born April 28, 1949
Tattoo: T-44

Bred by J. A. Shackelford
Martinsville, Virginia

Ka Del Royal Leader 2322989	MF Royal Leader 2233385	Edellyn Royal Leader 2057560
		Edellyn Nonpareil 12 2087431
	Missie Ka Del 3 2189826	Maxwalton Red Baron 2040475
		Missie Ka Del 1985376
Golden Flora Lassie 2361705	Glenburn Gold Cup 243581	Klaymor Royal 226788
		Glenburn Myrtle 6 280421
	Golden Flora Duchess 308374	Rosewood's Victor 244575
		Golden Flora Princess 2 296692

The Grassdale Leader bull was used from 1950 through 1956. Two non-inbred sons were used, FR Lord Leader 1118 in 1956 and Grassdale Leader of FR 13 (#988) in 1957, before the line was discarded in 1958 because of a Vibrio infection. At that time the Grassdale Leader foundation daughters and their female descendants were removed from the type and growth selection herds.

Grassdale Leader had three non-inbred sons used in selection herds. They were: FR Lord Leader 1119, type bull in 1956, and Grassdale Leader of FR 7 (#940) and Grassdale Leader of FR 25 (#1060), growth bulls in 1953 and 1955, respectively.

BRITOMAC PRINCE COMMAND 2686140

Born January 19, 1952
Tattoo: B287

Bred by Carl D. McKenzie
Armington, Illinois

Air Raid Marshal 2510563	Naemoor Marshal 345049	Cruggleton Prince Bob 328406	Cruggleton Perfect 303904
			Princess Bluebell 240829
		Naemoor Buttercup 2 211086	Beaufort Charm 274953
			Naemoor Butterfly 5 170611
	Clipper Wind Dream 2510562	Kirkton Air Raid 328077	Calrossie Cavalier 309513
			Rosewood Mona 240520
		Clipper Windflower 220443	Calrossie Brdhks Bounty 2844416
			Connie Clipper 130771
Britomac Augusta 16 2509498	Morphie Command 2455478	Bapton Commando 329336	Bapton Upright 316211
			Bapton Augusta 20 222124
		Morphie Victoria 2 268097	Calrossie Victorious 315175
			Balthayock Victoria 38 229126
	Britomac Augusta 8 2272168	Britomac Jasper 2119625	Millhills Jasper 2029367
			Sni-A-Bar Nonpareil Gem 2031751
		Augusta Queen 20 1792178	Browndale Ruler 1714780
			Augusta Queen 13 1645092

Britomac Prince Command was first used in the Shorthorn type selection herd in 1953. He was later chosen and used as a foundation sire through 1961.

Performance of Britomac Prince Command on test at Front Royal in 1952-53 was: pre-test gain, 1.86; age on test, 271; number days on test, 167; beginning weight, 570; ending weight, 889; ROP gain, 2.03; yearling type score, 15.3; and, total daily gain, 1.94.

The Britomac line, S-4, is now headed by an inbred son, FR Britomac Prince 9158.

PRINCE ERIC 2655343

Born March 27, 1951
Tattoo: 114

Bred by Berl A. Wilson
Champaign, Illinois

<table>
<tr><td rowspan="8">Ringwell Prince Eric 2561693</td><td rowspan="4">Barquhar Commander 2532130</td><td rowspan="2">Calrossie High Finance 315167</td><td>Calrossie Randolph 275440</td></tr>
<tr><td>Calrossie Eve Rosewood 210266</td></tr>
<tr><td rowspan="2">Kinellar Ury Maid 17 257604</td><td>Harviestoun Cossack 314752</td></tr>
<tr><td>Kinellar Ury Maid 11 226377</td></tr>
<tr><td rowspan="4">Ringwell Sylvia 2438762</td><td rowspan="2">Klaymor Heir 2274161</td><td>Aldie Reynoldstown 1998768</td></tr>
<tr><td>Klaymor Princess Royal 8 312803</td></tr>
<tr><td rowspan="2">Silver Creek Sylvia 3 2212517</td><td>Leveldale Sequel 2065729</td></tr>
<tr><td>Highland Roan Lady 2 1933788</td></tr>
<tr><td rowspan="8">Mario's Lucia 2475717</td><td rowspan="4">Mario's Prince 2319197</td><td rowspan="2">Edellyn Mario Mercury 2159987</td><td>Calrossie Mercury 1957318</td></tr>
<tr><td>Clipper Christobel 1921253</td></tr>
<tr><td rowspan="2">Susanna's Princess 2174204</td><td>Silver Coin 2009149</td></tr>
<tr><td>Radiant Princess 2 2030018</td></tr>
<tr><td rowspan="4">Illini Lucia 2002883</td><td rowspan="2">Reserve Field Marshal 1816201</td><td>Clifton Field Marshal 1716586</td></tr>
<tr><td>Rosewood B 6 1695654</td></tr>
<tr><td rowspan="2">Illini Loveliness 1475019</td><td>King Dreadnaught 2 1093596</td></tr>
<tr><td>Lovely Cumberland 922083</td></tr>
</table>

Prince Eric was used first in the type selection herd in 1952, and as the foundation sire of the S-5 line since 1953. But for limited use of an inbred son, FR Prince Eric 189, in 1961, this foundation sire has been the only one used in the Prince Eric inbred line.

Performance data of this foundation sire as a weanling calf in 1951 were: pre-test gain, 1.66; age on test, 204; number days on test, 168; beginning weight, 404; ending weight, 782; ROP gain, 2.25; yearling type score, 13.8; and, total daily gain, 1.96.

The Hereford breeding program was delayed by dwarfism. Two bulls chosen as foundation sires in the middle 1950's, and with nearly all of the required 32 daughters produced, were detected as carriers of the Snorter dwarf gene. Rather than confuse or complicate the experimental studies of normal growth and development, all known or possible carriers were used for dwarf test purposes at Front Royal or elsewhere, or were sold for slaughter. Another bull was originally designated as a foundation sire, but a more complete examination of his progeny indicated that the original decision, made under the strain of dwarf troubles, was in error, and his nearly complete foundation set was discarded. Thus, there is no H-1 line.

But, out of these delays, the index selection herd was born. By increasing the required number of foundation daughters from 32 to 40, it was possible, and still not too late, to establish on an equal footing the index herd described in an earlier section. This addition is felt to have greatly strengthened the basis of studies to be made with Herefords.

Hereford selection herds were first operative in 1961.

H-2 Perfect Domino

RF PERFECT DOMINO 62 P7842586

Born March 2, 1953
Tattoo: R322

Bred by George C. Palmer II
Charlottesville, Va.

Alf Perfect Domino 3 5561791	Perfect Domino 3 4688410	Beau Perfect 246 3252486	Beau Perfection 234 2729220
			Miss Perfection 65 2611680
		Sunset Flora A 5 3730345	Advanced Domino 38 2597667
			Sunset Flora A3 2920163
	Alf Bluebonnet 15 4616269	CMR Choice Domino 3804156	CMR Adv Domino 3260463
			Patricia 5 2752876
		Miss Mischief 16 2752065	Advance Mischief 2 2248200
			Miss Beau 100 2065657
RF Choice Domnet A17 5759269	RF Choice Domino 2 4666550	R Choice Domino 11 3434288	Choice Domino 39 2565179
			Bonnie Mischief 357 2779775
		Miss Lassie 3789406	Supreme Anxiety 7 3122803
			Lassie Girl 2094745
	SV Miss Homemaker 4 4315154	Home Builder 161 3105113	Home Builder 107 2670728
			Miss Benefactor 1966949
		Joice Domino 3341433	Advance Domino 86 2236121
			Phyllis Domino 2287210

RF Perfect Domino 62 was chosen as a foundation sire on the basis of his first two calf crops. He was used until 1961, when slaughtered after showing reduced fertility. An inbred son, RF Perfect Dom 9157 was used artificially in 1960 and a non-inbred son, RF Perfect Dom 125, has been used since 1961.

Postweaning data of this foundation sire were: pre-test gain, 1.95; age on test, 227; number days on test, 167; beginning weight, 507; ending weight, 821; ROP gain, 1.88; yearling type score, 14.5; and, total daily gain, 1.92.

COASTAL BEAU ROLLO 9 P6741418

Born February 15, 1951
Tattoo: 373

Bred by Coastal Plains Experiment Station
Tifton, Georgia

- Alf Beau Rollo 56 4933840
  - Beau Perfect 246 3252486
    - Beau Perfection 234 2729220
      - Beau Perfection 100 2065613
      - Miss Perfection 37 2370935
    - Miss Perfection 65 2611680
      - Sir Perfection 1966044
      - Mossy Girl 53 1861552
  - Daisy Domino 2 3077907
    - Victor Domino 99 2617747
      - Victor Domino 2060000
      - Miss Domino 44 1607875
    - Rothschild Prnss 170 2626661
      - Donald Domino 1720762
      - Princess Domino C11 2155136
- Coastal Sir Pearl 4768349
  - Coastal Sir Grove 3559615
    - Sir Perfection 66 2617743
      - Sir Perfection 1966044
      - Miss Domino 69 2156899
    - Bonnie Mischief 2121303
      - Ilo Mischief 1850497
      - Lady Grove 1302109
  - Coastal P Lucy 3559607
    - Coastal Perfection 2508619
      - Cyrus 2154180
      - Miss Beau 128 2106483
    - Coastal Miss 2635334
      - Cyrus 2154180
      - Miss Prince 29 2065709

The Rollo bull was chosen as a foundation sire on the basis of his progeny performance at Tifton and at Front Royal. This sire, loaned in 1959 and still in service with the Virginia Artificial Breeding Association, was used at Front Royal through 1961.

An inbred son, FR Beau Rollo 25 was also used in the H-3 line in 1961. A non-inbred son, FR Beau Rollo 79, used in the growth herd in 1961, now heads this line.

NPC MCHENRY 6497 9632052

Born September 19, 1956
Tattoo: 6497
Ear tag: 8801

Bred by Northern Pump Company Farms
McHenry, Illinois

Mill Iron C 182 5313609	Colo Domino M 32 3938568	Colorado Domino E 10 2693740	Prince Domino 101 1904037
			Princess Domino 490 2317526
		Princess Domino F 160 2841192	Colorado Domino 276 2440063
			Princess Domino 683 2467521
	Mill Iron Queen 81 3718217	Colorado Domino F 341 3026587	Colorado Domino E 6 2712825
			Mischief Lass 328 2554286
		Mill Iron Cora Q 2888441	Royal Domino 8 2499337
			Mill Iron Sally J 2429185
Miss Mill Iron A 423 4671970	Mill Iron Dom 413 3758598	Colorado Domino 697 2589485	Colorado Domino 28 2225193
			Belle Dominator 42 1836585
		Miss Adv Jr Domino 2601261	Onward Domino Jr 2 1873689
			Miss Adv Domino 28 2236131
	Miss Mill Iron 8 3860825	Royal Domino 8 2499337	WHR Royal Domino 45 2080595
			Donna Anna 42 1576265
		Mill Iron Nora T 2946306	Modern Domino 2109510
			M's Blanche 2115240

The McHenry bull was chosen as the third foundation sire on the basis of his impressive growth as a calf, and similarly impressive performance of paternal half-sibs. The bull, currently on loan to the Virginia Artificial Breeding Association, Rocky Mount, has one non-inbred son, FR Mill Iron 1560, used in the type herd in 1962-63, and another, FR Mill Iron 69, first used in the H-4 line in 1962.

DOMINION SILVER MR10 11193224

Born June 8, 1960
Tattoo: 0504
Ear tag: 0811

Bred by Still House Hollow Farms
Hume, Virginia

MR Real Silver Aster 9848283	Real Silver Dom 250 8591014	Real Silver Dom 155 6848309	HCR Silver Dom 12 B 4965747
			Anna Belle 4315365
		H&D Miss Silver 3 5365603	Real Silver Dom 44 3317191
			Miss Vagabond 122 4495142
	Bettie Aster 55 6658833	Mischief Real 4393890	Real Prince D 78 2589593
			Miss Ruby 2582939
		Bettie Aster 4747627	Advance M 14 2937222
			Bettie Domino 2 2648218
Miss Double Zato 13 9888761	Washita Heir 11 7506628	Zato Heir L 500 6186860	Zato Heir P 47 5227633
			Lady Anxiety 87 3977174
		Zato Rose 3758256	Hazford Zato 2369245
			White Rose 3188477
	Excel Tone 5 5935815	Ranzah Tone 35 4702699	Washita Tone 82 3361175
			Queen Zato 3256764
		Excel Tone 2 3599002	Washita Tone 26 2835505
			Excel Hazford 2171118

Dominion Silver MR10 was removed from ROP test at a year of age when chosen, solely on the basis of his performance, as the foundation sire for the H-5 line. Approximately 30 of this bull's first calves will be performance tested in 1962-63.

At the time he was taken from his ROP test, Dominion Silver's results were: pre-test gain, 2.20; age on test, 271; number days on test, 98; beginning weight, 665; ending weight, 975; ROP gain, 3.16; and, total daily gain, 2.68.

PERFORMANCE SUMMARY

Results in this section pertain only to calves born and raised at the Front Royal station.

Birth to Weaning

Several routine observations are made on each calf as it develops from birth through weaning. During calving season, usually from mid-January until mid-April, pastures are patrolled frequently each day. At birth each calf is weighed and assigned a grade. The numerical coding for each grade is that used in the S-10 Regional Project and is as follows:

High Choice	14
Middle Choice	13
Low Choice	12
High Good	11
Middle Good	10
Low Good	9
etc.	

Horned calves are dehorned electrically, usually before reaching six weeks of age.

In late June or early July, when calves are approximately 120 days of age "midsummer" data are obtained. These include a conformation score, or grade, which is an average of scores assigned by three or more graders, and a weight from which average daily gain is computed. Midsummer observations are obtained to determine their predictive value in assessing the performance of the calf, its dam, and its sire at an age earlier than conventional weaning (i.e., 6-8 months).

A weight and grade are recorded again for each calf in late August or early September, in a manner similar to that of midsummer.

New calves are individually identified by ear tag and tattoo when birth weight and dam identification are recorded.

A summary of results from an analysis of these data (calf performance from birth through weaning, 1950-61) appears in table 2. A more detailed summary by sires and lines appears in appendices IV-VI. Values shown therein are estimates from least squares analyses of data with unequal numbers in the various classes (e.g., year and sex). For the true value of each effect (e.g., year, sex) this method provides an estimate free from the complication, or bias, which otherwise arises because, for example, a different number of bull and heifer calves are included in each of several years.

TABLE 2. CALF PERFORMANCE FROM BIRTH TO WEANING BY FOUNDATION AND INBRED, TYPE, GROWTH, AND TEST HERDS, 1950-1961 INCLUSIVE

Kind of Herd	All Calves			Birth to Weaning Data[a]						A.D.G. Mid-summer to Weaning
					Midsummer Data			Weaning Data		
	No. Born (Alive & Dead)	F of Dam	F of Calf	Birth Weight	Weight[b]	A.D.G.	Type Score	A.D.G.	Type Score	
ANGUS										
Foundation and inbred	511	.02	.08	61.3	263	1.68	10.6	1.68	11.2	1.72
Type selection	106	0	.04	58.6	257	1.66	11.3	1.69	11.9	1.73
Growth selection	107	.01	.02	64.2	276	1.77	11.1	1.76	11.5	1.73
Test	278	.01	0	59.9	269	1.74	10.8	1.72	11.5	1.70
Breed average	1002	.02	.06	61.1	266	1.70	10.8	1.70	11.4	1.72
SHORTHORN										
Foundation and inbred	545	.09	.12	67.8	249	1.51	10.1	1.48	10.7	1.40
Type selection	137	.06	.04	68.7	250	1.51	10.2	1.48	10.9	1.39
Growth selection	164	.05	.05	70.4	257	1.55	9.9	1.55	10.6	1.50
Test	230	.08	.05	69.0	252	1.53	10.1	1.52	10.8	1.48
Breed average	1076	.08	.09	68.4	251	1.52	10.1	1.49	10.7	1.42
HEREFORD										
Foundation	310	.01	.01	67.7	272	1.70	10.7	1.65	11.1	1.60
Test	786	0	.01	66.3	248	1.51	10.4	1.51	10.6	1.51
Breed average	1096	0	.01	67.3	264	1.65	10.6	1.62	11.0	1.58
ALL PUREBRED	3174	...	...	....	...	....	....	....	....	....
CROSSBRED	168	...	...	....	...	....	....	....	....	....
HERD TOTAL	3342	...	...	....	...	....	....	....	....	....

[a] Results from calves with complete data through weaning; 785 Angus, 853 Shorthorn, and 802 Hereford.

[b] Adjusted to 120 days of age.

Several important qualifications should be borne in mind in the interpretation of these results:

First, the data cover a 12-year period. Estimates presented necessarily represent the mid-point for all available observations of that group (e.g., foundation and inbred, type, growth, etc.). Trends with time, therefore, cannot be seen clearly from such single point estimates. For example, for inbred groups, calves' and dams' inbreeding coefficients for 1962 are shown in table 3. These values, when compared with those in table 2, show an obvious and expected increase in inbreeding levels with time. A more accurate and reliable measure of trends in growth and type with time will require a more complete analysis of existing data.

TABLE 3. AVERAGE LEVELS OF INBREEDING OF 1962 CALVES AND OF THEIR DAMS IN THE ANGUS AND SHORTHORN INBRED LINES

Inbred line	In breeding Coefficients	
	Dam	Calf
ANGUS		
A-1 Eileenmere	.20	.27
A-2 Rock Delus	.15	.28
A-3 Elkton	.03	.22
A-4 Blackwood Bandy	.04	.22
Inbred average	.10	.25
SHORTHORN		
S-1 Statesman	.26	.38
S-2 Lord Rothes	.28	.38
S-4 Britomac	.02	.24
S-5 Prince Eric	.07	.26
Inbred average	.16	.32

Second, most test matings were made during the early years of the project. As foundation sires were chosen, and their foundation daughters produced and allocated to permanent breeding groups, the need for further testing rapidly decreased. Because of this, comparisons of results from the test calves with those of the inbred, type, or growth groups contain greater time differences than is true of comparisons among the latter three groups, which are of most interest.

Third, many non-inbred calves were produced during the early years of each foundation sire's use. Data from such calves appear with the inbred group headed by their sire. This is one reason for the large number of calves in the inbred groups, and for their relatively low levels of inbreeding.

Remarks immediately below deal with the interpretation of results in table 2, but apply equally to results in appendices IV-VI.

Birth weights of calves in the Angus and Shorthorn growth selection herds are heavier than those of calves in the type selection herds of their respective breeds. Selection for growth rate constitutes, to some degree, selection for general size, apparently manifest even at birth. The observed differences should not be interpreted to mean that selection for type will depress birth weight. Subsequent differences in weight and gain show differences similar to those which exist at birth. Angus calves are clearly lighter at birth than Herefords or Shorthorns.

Average daily gains to midsummer and weights at that age (120 days) follow a pattern like that shown in birth weight. The Angus and Shorthorn type and growth selection herds show separation in the characteristics for which each has been selected; absolute differences are small, but relative to variation among individual calves, the differences are considered real. Somewhat larger absolute differences in the same characteristics may be seen at later ages.

From midsummer to fall, the calf is more nearly on his own, so that gains during this period reflect more accurately the calf's own genotype for growth rate. Gain from midsummer to fall is measured over a period approximately half as long as that for gain to midsummer, and only a third that for gain to fall. It is calculated as the difference between midsummer and fall weights; consequently, sampling errors of this gain are nearly twice those for either of the other estimates. For most groups average daily gains from midsummer to fall will be above (or below) those of midsummer by approximately twice as much as those at weaning.

Performance of Hereford calves by foundation bulls is clearly superior to that of calves by other Hereford bulls tested.

Postweaning

Bull, heifer, and steer calves on ROP tests are routinely weighed at 28-day intervals. Special studies of weight changes required additional individual weights at shorter intervals.

Following weaning most calves are placed on record-of-performance (ROP) tests. The numbers of calves with complete performance records are shown in appendix X.

Postweaning tests are conducted to measure individual gaining ability. At the conclusion of each test, all calves are again scored for conformation. Regardless of the calf's subsequent use, each contributes information toward the overall estimate of the breeding value of its sire, dam, and line.

The discussion of calf performance from birth through weaning was preceded by several qualifications dealing with the method of analysis and origin of data. Those qualifications are equally appropriate in the interpretation of postweaning results. In addition, the method of analysis of postweaning data was quite different. Values reported are simple averages across years, with no allowance or correction made for differences caused by changes from one year to the next in rations, seasons, duration of the tests, or other management factors. Also, there is a tendency for the calf to compensate for an unfavorable preweaning environment (e.g., young dam, temporary injury or illness, etc.). This is the calf's "built-in" (biological) adjustment factor. Other workers have reported this compensatory effect in studies of postweaning gains, but no adjustment was made for it in the results presented below, nor in the corresponding appendices.

Bulls

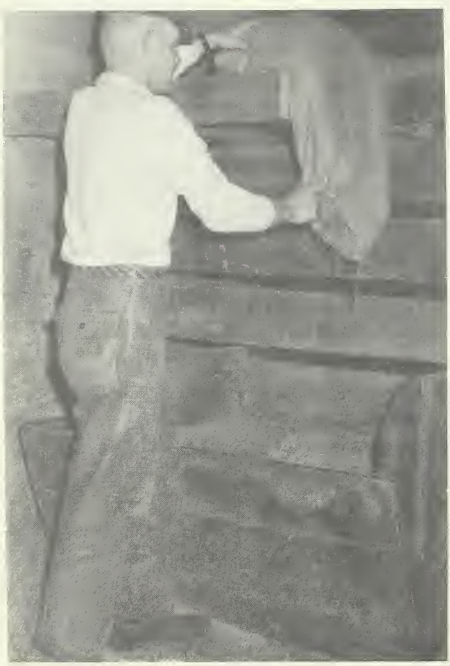
Since 1950, each year approximately 50 bull calves have been performance-tested. During the early years a large fraction of the calves tested were loaned by cooperating breeders, the calves being tested as foundation

sire prospects. Currently, where numbers permit, one or more male calves from each inbred line and one or more by each selection herd sire are placed on the performance test. An effort is made to purchase at least four calves which, upon completion of the test, may qualify for use in one of the selection herds of each breed.

Bull calves chosen from the Front Royal lines are those considered to be superior at weaning age. For this purpose, "superior" is defined for calves from the growth herd as "fastest growing" regardless of type, for calves from the type herd as "best type" regardless of growth rate, and for calves from the inbred lines and the index selection herd as "best index" (i.e., an index giving equal emphasis to growth and type).

During the early years, bull calves were fed hay and concentrates separately. Since 1951, these components have been mixed, in order that differences in growth rate will not be confused with individual differences in preference for hay or concentrates. A typical ration used in a recent year was:

Molasses	150 lbs.
Corn-and-cob meal	1050 "
Linseed oil meal	150 "
Cottonseed oil meal	150 "
Alfalfa hay	250 "
Orchard grass hay	250 "
	2000 "



Until 1960, bulls placed on postweaning ROP tests were individually fed. This permitted measurement of individual feed consumption, but required that bulls be released from their individual stalls for water thrice daily.

Analysis of records from bulls fed individually through 1957 showed that average daily gain and feed efficiency are highly correlated genetically; generally, faster gaining bulls are also more efficient. In 1960 and 1961, 94 bulls were group-fed in lots of about 12 head, each. Their gains were 2.58 lbs. per day compared with gains of 2.19 lbs. per day from individually feeding 501 bulls from 1950-59, including many not born at Front Royal. Thus, social behavior in cattle apparently does affect their eating habits and appetites.

TABLE 4. BULLS' POSTWEANING PERFORMANCE BY FOUNDATION AND INBRED, TYPE, GROWTH, AND TEST HERDS, 1950-1961 INCLUSIVE

Kind of Herd	No. on Test	Age of Dam	F of Calf	Begin. Weight	Ending Weight	Test ADG	Yearling Type Score
ANGUS							
Foundation and inbred	83	5.0	.10	488	878	2.32	11.4
Type selection	15	4.8	.04	493	886	2.34	12.2
Growth selection	17	5.7	.02	512	922	2.44	11.3
Test	32	6.4	0	496	851	2.11	10.9
Breed average	147	5.5	.04	497	884	2.30	11.4
SHORTHORN							
Foundation and inbred	79	6.2	.12	454	862	2.44	11.2
Type selection	21	5.5	.02	445	865	2.50	12.2
Growth selection	19	4.7	.07	450	895	2.65	10.5
Test	25	4.6	.04	448	849	2.39	10.9
Breed average	144	5.2	.06	449	868	2.50	11.2
HEREFORD							
Foundation	41	6.6	.02	494	908	2.46	11.4
Test	64	6.3	0	435	776	2.04	10.4
Breed average	105	6.4	.01	464	842	2.25	10.9
ALL PUREBRED	396	...	...	...	...	....	....
CROSSBRED	50	...	...	...	...	....	....
HERD TOTAL	446	...	...	...	...	....	....

Bull calves' performance test results appear in table 4 and in appendix VII. As was true of the preweaning results presented, and as is true of postweaning performance of heifers and steers shown in the following sections, results of many non-inbred calves by the foundation sires are included in the class "foundation and inbred." In both the Angus and Shorthorn breeds, results indicate separation of the two selection herds in the criteria being selected. Absolute differences are larger in Shorthorns, where selection herds have been in existence longer. Performance of Hereford foundation calves is clearly superior to that of calves by test bulls in earlier years.

Heifers

With few exceptions, all heifer calves born at Front Royal were performance tested. In some instances, heifers by bulls being progeny tested, were transferred to other Virginia substations for experimental studies.

The length of the heifers' ROP test period varied from year to year, being 80 days in 1952-53, 105 days in 1953-54, and generally 140 days each year thereafter. In the early years, heifers were weaned in October, fed 1-2 lbs. of concentrates per head day but kept on pasture until late December or early January, then fed 6 lbs. per head day of a hay-grain mixture much like that fed bulls, plus silage and/or hay ad lib. This practice restricted gain following weaning prior to the official ROP test and produced test gains which frequently exceeded 2 lbs. per day although final weights at approximately 13-14 months of age were similar in all years.

Since 1954, heifers have been weaned in late October, placed directly on test, receiving corn silage or wet apple pomace ad lib, and 6 lbs. per head day of a hay-grain mixture similar to that fed bulls.

Heifers were fed individually in 1950 and 1951, but group-fed in lots 15-30 head each, since 1952. Heifer calves were grouped by breed from 1952 to 1956 but, to reduce competition among calves within lots, have been grouped according to initial weight since 1957.

Comparison of heifer performance (table 5) in type and growth selection herds of both Angus and Shorthorn breeds shows separation between the two herds in the characteristics being selected, i.e., type and growth. As was true with bulls (table 4), absolute differences between the two herds are larger in Shorthorns than in Angus. In heifers, however, average differences in type and growth of calves from the type and growth selection herds are smaller than similar differences in bulls. This is due, in part, to a more intense selection of bull calves chosen for ROP testing from each line and herd, whereas <u>all</u> heifers of each line and herd are tested after weaning.

TABLE 5. HEIFERS' POSTWEANING PERFORMANCE BY FOUNDATION AND INBRED, TYPE, GROWTH, AND TEST HERDS, 1950-1961 INCLUSIVE

Kind of Herd	No. on Test	Age of Dam	F of Calf	Begin. Weight	Ending Weight	Test ADG	Yearling Type Score
ANGUS							
Foundation and inbred	215	5.2	.07	463	646	1.41	11.6
Type selection	29	5.0	.03	449	622	1.22	12.1
Growth selection	43	4.4	.02	451	644	1.34	11.6
Test	58	5.3	0	459	624	1.52	11.5
Breed average	345	5.0	.03	456	634	1.37	11.7
SHORTHORN							
Foundation and inbred	200	5.9	.16	420	606	1.46	11.0
Type selection	48	5.2	.04	417	617	1.61	12.1
Growth selection	73	5.5	.04	431	650	1.71	11.3
Test	61	5.6	.08	418	596	1.63	11.6
Breed average	382	5.6	.08	422	617	1.60	11.5
HEREFORD							
Foundation	115	5.7	.02	416	593	1.23	11.0
Test	193	6.0	.02	388	567	1.51	10.8
Breed average	308	5.8	.02	402	580	1.37	10.9
ALL PUREBRED	1035	...	...	...	...	....	....

Angus heifer calves of the test group and of the foundation and inbred group appear better in growth rate to calves of the type and growth herds, partly because a large number of the calves in the former two groups were tested in early years when, as described above, tests were shorter and test gains much higher than in recent years. This is also true of the apparent difference between foundation and test Hereford heifers.

Steers

Prior to 1955, steer calves at weaning were transferred for use in feeding tests at other Virginia substations. Since 1956, a number of steers (from 25-60 head, annually) have been fed at the Front Royal station.

It has been planned that, where numbers permit, at least three steers from each inbred line and at least three steers by each selection herd sire would be performance tested. In contrast to criteria used in the choice of bulls tested from each line, steers placed on test are chosen at random from among those not fed as bulls. Excess steers are fed at other Virginia substations.

TABLE 6. STEERS' POSTWEANING PERFORMANCE BY FOUNDATION AND INBRED, TYPE, GROWTH, AND TEST HERDS, 1950-1960 INCLUSIVE

Kind of Herd	No. on Test	Age of Dam	F of Calf	Begin. Weight	Ending Weight	Test ADG	Yearling Type Score
ANGUS							
Foundation and inbred	42	5.5	.16	509	865	1.78	10.9
Type selection	19	4.6	.03	479	850	1.77	11.5
Growth selection	20	4.8	.02	486	868	1.83	11.1
Test	3	6.7	0	532	907	1.91	10.3
Breed average	84	5.4	.10	505	872	1.80	10.9
SHORTHORN							
Foundation and inbred	75	5.7	.14	433	843	2.04	11.5
Type selection	20	4.2	.05	450	867	1.96	11.9
Growth selection	27	4.1	.05	444	893	2.25	11.7
Test	6	5.2	.04	427	886	2.34	13.3
Breed average	128	5.2	.10	438	858	2.09	11.8
HEREFORD							
Foundation	41	5.0	.01	442	867	2.01	11.0
Test	34	5.4	0	487	856	1.87	11.0
Breed average	75	5.1	0	453	864	1.97	11.0
ALL PUREBRED	287	...	...	...	...	....	....

Steers are weaned in middle or late October, placed directly on test, and group-fed, usually about 200 days. The steers are then transferred to the Meats Quality Laboratory at Beltsville for slaughter and detailed carcass analyses. At slaughter, most steers will grade high good or low choice.

The steer fattening ration has varied from year to year. In 1960-61, steers were fed a hay-grain mixture identical to that fed bulls (described earlier) and, in addition, received corn silage ad lib.

Results of steer performance appear in table 6 and appendix IX. Differences in type (slaughter grade) and growth (ROP test gains) between steers of the type and growth selection herds in Angus and Shorthorn breeds are in agreement with pre and postweaning results of bulls and heifers, i.e., with calves from the type herds showing slightly better conformation than calves from the growth herds, and conversely for growth rates.

In steers, yearling conformation scores (slaughter grades) are more nearly an index of condition than is true of conformation scores of yearling heifers and bulls. Thus, in both breeds with selection results, but particularly in Shorthorns, the growth herd steers' advantage in growth rate apparently improved their condition and slaughter grade enough to sharply reduce the type herd steers' advantage in type.

Conclusions

Results in the preceding section were obtained after compiling performance data at various ages from 3342 calves born at the Beef Cattle Research Station between 1950 and 1961. More than half of this time was devoted to testing and screening several herd sire prospects in order that the foundation stock from which the breeding experiment developed would compare favorably in quality with most purebred herds. Comparisons of the performance of the type and growth selection herds, each originating from a common genetic base, have been described briefly. Performance of foundation and inbred calves was reported, but detailed comparisons among and within inbred lines were not made.

As seen in table 2, at weaning age average type scores of calves from the type selection herds showed an advantage of .4 unit in Angus and .3 in Shorthorns over calves from the growth selection herds of their respective breeds. On the other hand, calves from the growth herds of both Angus and Shorthorn breeds held an advantage of .07 lbs. per day over calves from the respective type selection herds.

Postweaning test results (table 4-6) of bull, heifer, and steer calves from the Angus and Shorthorn selection herds showed much the same pattern, similar comparisons showing generally larger differences. Bull, heifer, and steer calves of the Angus type selection herds had yearling type scores

which were .9, .5, and .4 unit, respectively, above those of the same sex in the Angus growth herd; Shorthorn type bull, heifer, and steer calves had advantages of 1.7, .8, and .2, respectively. A unit of type score is equivalent to 1/3 of a feeder grade.

In growth rates on postweaning tests, calves from the Angus and Shorthorn growth herds showed an advantage over calves from the type herds of each breed. Angus growth bull, heifer, and steer calves' growth rates were .10, .08, and .06 lbs. per day, respectively, better than those of the same sex in the type herd. Shorthorn growth bull, heifer, and steer calves held advantages of .15, .10, and .29 lbs. per day, respectively, over the type selection calves of the same sex.

This seems conclusive evidence that a breeder can change type, growth, or both in his herd by using performance records.

Studies of inbreeding have not yet progressed to the point where the value of this technique may be reliably assessed. In results at Front Royal, and elsewhere, effects of inbreeding per se upon calf performance have generally been unfavorable, although quantitative estimates of these effects are not reported herein. Wide variation among progeny averages of several inbred sires and lines is evident. Outstanding calves, although rare, have been produced in several of the inbred lines. Available data indicate rather clearly that any conclusions on the value of the inbreeding studies with beef cattle at Front Royal must await additional information on the test-crossing abilities of the several inbred lines.

PUBLISHED RESULTS

Results of the experimental work at Front Royal are summarized periodically, and written technical reports of various forms are prepared. Each of these reports, most of which are available at or through the Beef Cattle Research Station office, appears in Appendix XI. A brief summary of the results and conclusions from each of these studies follows. Numbers in parentheses appearing after each subject identify the technical report(s) from which this summary was prepared.

Breeding

Cow Performance (11, 22)

A breeder may cull or keep a young cow based on the performance of her first calf or two with reasonable confidence that his choice has been correct.

A study of data from 1038 calves raised by 364 cows from 1950 through 1956 disclosed that in consecutive years a cow's calves tend to rank similarly in birth weight, conformation, and growth to weaning age. Average repeatabilities were: birth weight, 0.30; average daily gain to midsummer, 0.41; average daily gain to weaning (average age of 200 days), 0.42; midsummer grade, 0.32; and, weaning grade, 0.23. This means that if the performance (i.e., birth weight, growth rate, conformation) of a cow's first calf is well above (or below) the average performance of first calves out of other cows of the same age, our best estimate of that cow's subsequent calves' performance is that they will differ from the herd average in the same direction, the probable size of the advantage (or deficit) being the repeatability times the deviation of the cow's first calf.

Heritabilities of Growth Rate, Conformation, and Feed Efficiency (4, 1, 9, 10, 14, 15)

A selection experiment with beef cattle was begun at the Blacksburg station in 1947 when several weanling Hereford bull calves received a postweaning performance test. During the following 5 years 123 bull calves were placed on a similar performance test at Front Royal. At the conclusion of each year's test, the fastest and slowest gaining bulls were selected for progeny testing on a group of Hereford cows maintained at Blacksburg. In all, 19 high-gaining and 19 low-gaining bulls produced 192 steers and 196 heifer calves whose postweaning gains were compared with those of their sires. Conclusions were: (1) growth rate and conformation are each approximately 1/3 heritable; this means that, on the average, about 1/3 of an individual's superiority (or inferiority) is genetic, the remainder being due to various environmental sources; (2) growth rate and conformation are genetically independent, so that selection for either character should not affect improvement in the other; (3) growth rate in pre- and postweaning periods are genetically correlated indicating that selection for improvement in either would be expected to improve both characteristics; and, (4) feed efficiency is approximately 60-70% heritable; selection for rapid growth based solely on individual gain would be expected to improve feed efficiency; fast gaining animals generally convert feed to beef more efficiently than slow gainers.

Growth of Heifers (23, 24)

Genes affecting growth early in life continue to influence growth at later ages.

Hereditary variation in growth rates was relatively larger in heifers than in steers in the selection study described above. An analysis of growth records of 646 calves produced by 70 sires from 1950-58 showed, in general, that birth weight, suckling gain, and postweaning gains through the winter on a limited feeding regime were of low to moderate heritability; pasture gains during the heifers' yearling summer were highly heritable in Hereford and Shorthorn calves, but low in Angus. Genetic correlations among the different growth periods from birth to yearling fall were favorable. Maternal effects (milk production and mothering ability) were largest during the period from birth to weaning.

Early Selection of Beef Calves (20, 21)

A cow's milking ability can be determined better by her calf's gain from birth to midsummer than by its gain from birth to weaning, and the calf's genotype for growth is best assessed at weaning age by its growth from midsummer until weaning.

A study of performance records of 1682 calves (536 Angus, 556 Hereford, and 590 Shorthorns), showed that growth to midsummer (about 120 days of age) and conformation at that time are good predictors of the calf's performance through weaning. As a calf grows from birth to weaning (approximately 200 days of age), the relative importance of his dam's milking ability gradually decreases and the calf's own genotype for growth rate asserts a relatively greater influence. For the most part, these findings confirmed earlier studies of cow performance.

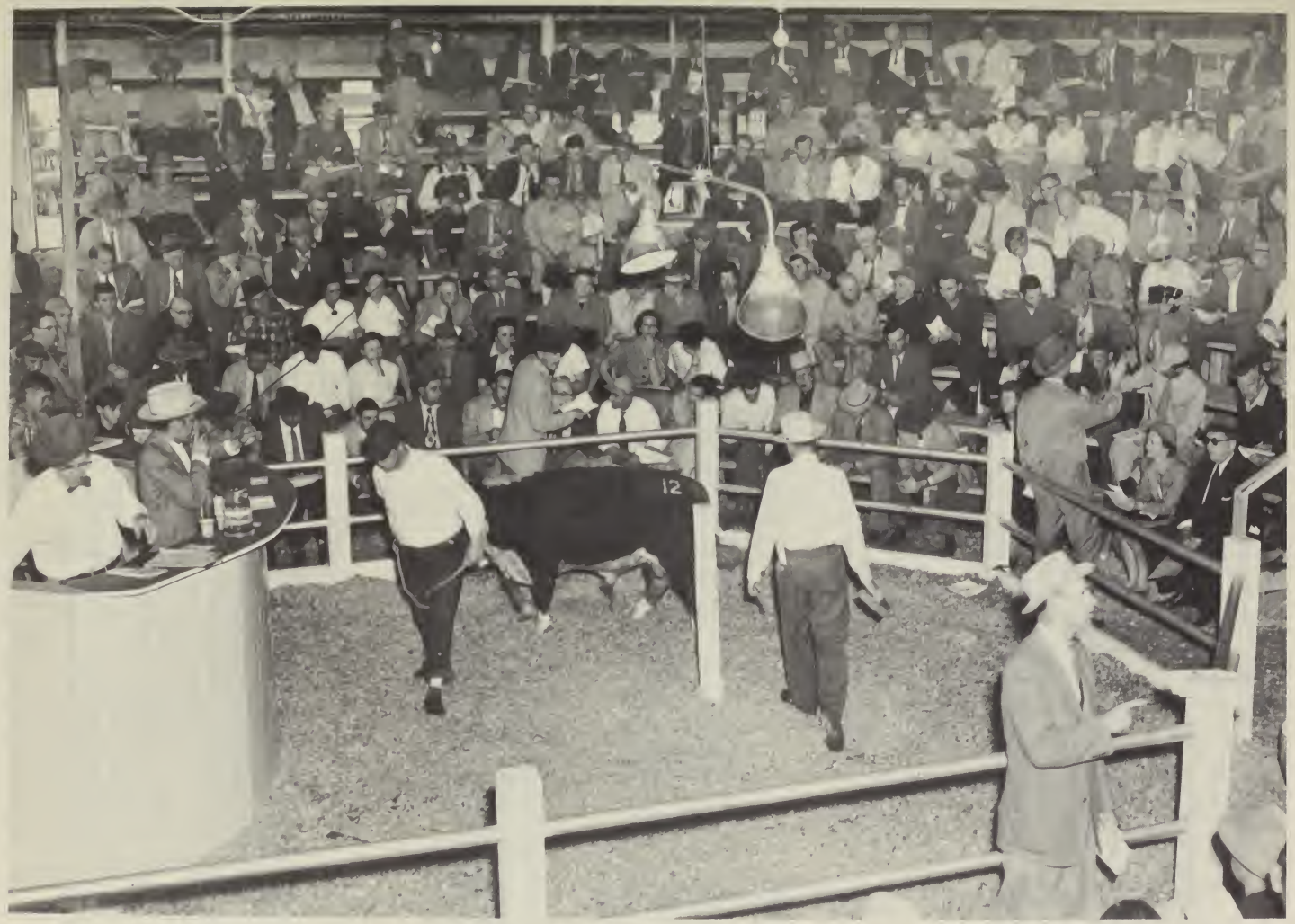
Weaning Indexes (16, 28)

An optimum index (i.e., optimum in the sense of maximizing genetic advances in characteristics of economic value) should include both growth rate and type.

Data from 1987 calves born between 1950-58 and by 105 sires confirmed earlier indications that growth rate and weaning type were genetically independent, and that selection for either should not antagonize improvement in the other.

Application of Breeding Results to Date

One of the most important commercial applications of the early work at Front Royal, and of similar work at other stations, was the establishment of the Virginia Beef Cattle Improvement Association (BCIA). From preliminary studies, growth rate and conformation of calves at weaning time were found to be sufficiently heritable (30-40%) to indicate that selection for these characteristics based solely on individual performance would be expected to produce genetic



At the conclusion of each year's performance test at Front Royal, bull calves excess to experimental needs and meeting acceptable standards were offered for sale at a public auction combined with the annual field day. Seven annual Field Day and Bull Sale events have been held at the station's sale pavillion; the last Field Day was in 1958.

improvement. The BCIA program, which now includes 208 breeders with approximately 9,500 calves annually, provides for individual observations of calves' conformation and weights, from which average daily gains are computed. They furnish members with individual, sire, and dam performance records and averages, so that each breeder may base his culling decisions on some definite performance records.

The BCIA program has grown since established in 1953. In 1958 this group organized its own postweaning performance testing program. At the conclusion of their tests, bulls having acceptable performance records are offered for sale at public auction. Sales have been attended by buyers from Virginia and several neighboring states, indicating that an increasing number of breeders recognize the value of information obtained through performance testing.

Reproduction

Calving Date (8)

A limited breeding season of approximately 90 days was followed from 1950 through 1957. This practice restricted the subsequent calving season, reduced but did not remove the need for adjustments due to differences in age among calves, and simplified management and handling of all cattle. With a fixed breeding season, however, cows which calve late are less likely to conceive during the subsequent breeding season.

In a study of 1483 records from cows calving, bred subsequently, and on hand the following year, 1230 calves were produced but 253 cows failed to conceive. Previous calving dates of the latter group were 15 days later than for cows calving in consecutive years. When records were arranged by 20-day intervals during the calving season, 6% fewer cows calved in the following year for each 20-day delay in calving date of any given year.

Occurrence of Estrus (6)

During the 1956 breeding season individual breeding dates were obtained for 467 cows. Apparent breeding dates were determined during an 80-day breeding season by painting each bull's brisket with a pigmented lubricating grease, then observing cows in breeding herds twice daily to identify cows which had been marked. This technique was not wholly accurate, however, since 8% of the cows became pregnant without any marks being observed, and apparently false markings showed that 20% of the 230 estrual cycles recorded were less than 16 days in length, and 7% of the cows were marked after becoming pregnant. Approximately 16% of the cows had intervals exceeding 80 days from calving to first estrus, with 7% not showing estrus until more than 100 days after calving.

Net Calf Crop (30)

Factors affecting net calf crop in beef cattle were investigated in records from 453 cows bred in 1956 and 429 bred in 1957. As shown in table 7, among cows examined for pregnancy approximately 60 days after the close of breeding season, and again in October, the largest losses in potential calf crop resulted from: (1) failure to conceive or early embryonic death prior to the first pregnancy examination and (2) death of the calf at, or shortly after birth. Conception rates of

TABLE 7. COWS PREGNANT AND CALVING AND CALF DEATH LOSSES
(as taken from reference 30, appendix XI)

Season and breeding group	Cows in breeding herds	Cows diagnosed pregnant				Cows diagnosed pregnant in October but failed to calve	Calf death losses			Net calf crop[a]
		Initial check		Check in October			At or near birth	Birth to 2 weeks of age	2 weeks of age to weaning	
	No.	No.	%	No.	%	No.	No.	No.	No.	%
1956 season										
Angus	145	132	91	130[b]	90	0	4	2	2	84
Hereford	135	118	87	112[b]	83	1	4	2	0	78
Shorthorn	173	148	86	146[b]	84	1	14	13	0	66
Total	453	397	88	388	86	2	22	17	2	75
1957 season										
Angus	139	133	96	130[c]	93	5	19	2	4	68
Hereford	152	133	88	133[c]	87	2	15	1	3	73
Shorthorn	138	114	84	114[c]	84	3	19	3	0	64
Total	429	380	88	377	88	10	53	6	7	68

[a] Calculations based on assumption that death losses in calves of pregnant cows sold would have been the same as for cows actually calving.
[b] 7 Angus, 2 Hereford, and 18 Shorthorn pregnant cows sold before calving.
[c] 20 Angus, 8 Hereford, and 4 Shorthorn pregnant cows sold before calving.

yearling bulls as shown in table 8 were only slightly less than for bulls two years old or more. Also, heifers and cows suckling calves had an average conception rate of 89.3% (N = 774), whereas conception rates were 8.3% lower for 81 dry cows.

TABLE 8. EFFECT OF AGE OF BULL ON CONCEPTION RATE
(as taken from reference 30, appendix XI)

	Bulls	Cows bred	Conceived 1st service	Cows served, diagnosed pregnant
	No.	Av. no.	%	%
Angus				
2 yrs. or older	7	23.0	72	96
yearling	6	20.0	68	94
Hereford				
2 yrs. or older	9	25.6	67	90
yearling	3	12.3	51	84
Shorthorn				
2 yrs. or older	7	26.6	58	88
yearling	7	19.1	57	81

TABLE 9. EFFECT OF *VIBRIO FETUS* ON CONCEPTION RATE

(as taken from reference 30, appendix XI)

Breed	Herds infected with *Vibrio fetus*				Non-infected herds			
			Services per conception				Services per conception	
	Pregnant		All cows	Cows which conceived	Pregnant		All cows	Cows which conceived
	No.	%	Av. no.	Av. no.	No.	%	Av. no.	Av. no.
Angus	50	64	3.50	2.09	284	93	1.49	1.34
Shorthorn	35	54	3.89	1.63	311	84	1.76	1.38

An infection of Vibrio fetus had an obviously unfavorable effect on fertility, as seen in table 9. Weighted average differences between infected and non-infected herds were 28.4% in conception rate and .54 in services per conception.

Artificial Breeding for Disease Control (26)

All cows bred artificially were gathered daily in corrals. Cows detected in heat were bred later that day.

Artificial breeding was considered a valuable technique in the handling of certain reproductive diseases where disposition of infected animals is not plausible.

During 1959 and 1960 all cows were bred artificially to eliminate an infection of Vibrio fetus. The long-term genetic study comparing inbreeding and selection required that specific bulls be used in each line, permitting essentially no freedom to select among bulls on semen quality. Working within these limitations, effects of the following factors upon conception rates were examined: (1) fresh vs. frozen semen, (2) one vs. two services during a single estrus, (3) age or lactation status, (4) stage of estrus at the time of breeding.

As shown in table 10 several sires used from 1956 through 1958 by natural service and used artificially in 1959 and 1960 had better conception rates by

natural service than by A.I. These 12 bulls ranked in approximately the same order when used artificially as when used naturally, but the variation among bulls was larger by A.I. This suggests that semen quality, as measured by conception rate, and as seen microscopically, is more critical in artificial than in natural breeding.

Per-service conception rates from fresh semen were 5% better than from frozen semen; and conception rates for cows bred once during an estrus period were not different from those of cows bred twice.

Because other workers had reported difficulties in detecting estrus among beef cows bred artificially, special emphasis was placed upon detecting and breeding cows showing any indication of estrus. Cows bred artificially in 1960 were classified according to their apparent stage of estrus (subjectively appraised) at the time of breeding, and according to the time when the first indication of estrus was observed. A cow was classified as "definite" (i.e., in "standing heat") if she would permit other cows to mount, but was classified as "doubtful" if she merely exhibited other common manifestations of estrus (e.g., anxiety, inflammation or swelling of the vulva, etc.). Per-service conception rates of cows in "definite" estrus were 4.4% better than those of cows believed "doubtful" at the time of service, as shown in table 11.

TABLE 10. CONCEPTION RATES FOR SIRES USED NATURALLY 1956-58 AND ARTIFICIALLY IN 1959-60 (TAKEN FROM REFERENCE 26, APPENDIX XI).

Sire No.	Breed-Line	Total cows in breeding herds [a]	Conception rates	
			Natural service	A. I.
57	A-2	97	84.9%	52.3%
420	A-3	93	77.2	28.7
890	A-4	134	84.5	54.1
1349	A-7	32	87.5	75.0
322	H-2	127	84.3	41.0
373	H-3	167	71.4	49.5
8801	H-4	196	65.6	58.5
885	S-1	99	79.3	48.9
B287	S-4	116	71.2	24.4
114	S-5	107	83.8	63.7
1443	S-7	37	73.7	38.9
1463	S-8	32	70.6	13.3
Total		1,237	78.5	50.4

[a]Total number of cows assigned to each bull from '56 through '60. Cows included in consecutive years are counted once for each year assigned.

TABLE 11. NUMBER OF SERVICES (AND PER-SERVICE CONCEPTION RATE) CLASSIFIED BY STAGE OF ESTRUS AT TIME OF BREEDING AND BY TIME ELAPSED SINCE ESTRUS WAS FIRST OBSERVED (TAKEN FROM REFERENCE 26, APPENDIX XI).

Stage of estrus	Hours elapsed since estrus was first observed			
	1-4	12-14	24-26	Total
Definite	574 (28.4%)	24 (12.5)	10 (20.0)	608 (27.6)
Doubtful	109 (22.0)	93 (21.4)	35 (17.1)	237 (23.2)
Total	683 (27.3)	117 (23.9)	45 (17.8)	845 (26.4)

Inbreeding and Conception Rates (31)

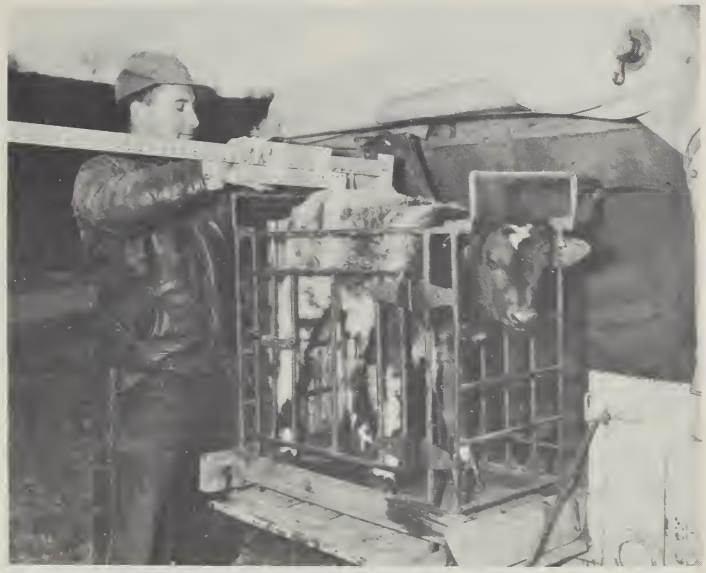
Results from 159 Angus and 146 Shorthorn cows in the 1961 breeding herds showed that inbreeding of the fetus and of the cow are detrimental to conception rate.

TABLE 12. AVERAGE INBREEDING OF FETUS AND OF COW AMONG ANGUS AND SHORTHORN COWS BRED IN 1961 (TAKEN FROM REFERENCE 31, APPENDIX XI).

Breed	No.	Inbreeding of Fetus (%)	Inbreeding of Cow (%)
Angus			
Pregnant	137	11.8	6.5
Not Pregnant	22	17.3	10.3
Shorthorn			
Pregnant	126	14.7	9.0
Not Pregnant	20	21.0	10.1

Other Studies

Linear measurements—height at withers, depth of chest, length of body, heart girth, circumference of cannon bone, and round measure were obtained at birth from all calves from 1952 through 1957.



Calf Measurements (19, 27, 32)

All calves were weighed at birth, assigned a conformation score, and a series of seven linear body measurements was taken during the years from 1950 through 1957. Data from 1425 calves indicated that the predictive value of birth measurements is extremely limited, and, in general, would tell too little about an animal's growth rate to weaning or his weaning conformation to be of practical value to the breeder.

Permanency of Conformation Scores (2)

Three judges working independently assigned conformation scores to 102 heifer calves at 3 different ages — midsummer (July, 1954), weaning (September, 1954), and the conclusion of postweaning tests (March, 1955). Scores for individual calves were fairly consistent, although wide variation among calves was seen at each age. Agreement of the judges with their own ratings of individual calves at different periods was better for consecutive periods than between the midsummer and yearling ages.

Dwarfism (3, 18)

A study of 33 normal and 8 Snorter dwarf calves out of Angus, conventional Hereford, and comprest Hereford dams and by one normal Angus and two normal Hereford sires disclosed that (1) the Snorter dwarf gene was either common to both breeds, or allelic to it but with similar effects, and (2) Angus-Hereford crossbred dwarfs

were faster-gaining than purebred dwarfs of either breed.

Dwarf research conducted at several stations throughout the United States from 1950 to 1960 revealed no phenotypic test sufficiently accurate to justify its practical application in breeders' herds. Among the several diagnostic criteria investigated were: (a) studies of head form, (b) radiographs of lumbar vertebrae, (c) anatomical measurements, including ratios of head length to head width, and of cannon length to cannon width, (d) other anatomical studies, including measurements of dried skeletal specimens, and estimation of heart shape from radiographs, (e) endocrine studies of growth and thyrotropic hormones, (f) studies of spinal fluid pressure, (g) blood studies and (h) cytological studies. Snorter dwarfs differed widely from normal animals in most of these characteristics; but, detailed studies among carrier and clean animals disclosed differences too small to be of practical value.

Dwarfism is now apparently a less serious economic problem than was true in the middle 1950's. Much of the reduction in dwarf frequency seems to have been accomplished by intense pedigree selection.

Phospholipids as Feed Additives (5, 13)

Certain carbonated vegetable phospholipids are obtained in the refining procedure for cottonseed and soybean meal. The physical consistency of several of these phospholipids makes them desirable for the reduction of dustiness in rations containing ground feeds. In 1955, 40 Shorthorn steers were fed four different levels of phospholipid, namely 0, .75%, 1.5%, and 3.0%, added to a basal ration. Groups receiving the additives showed small but consistent increases in average daily gain and in feed efficiency. The apparent absence of harmful effects indicated that the phospholipids tested were desirable additives to rations for fattening beef cattle.

Apple Pomace Studies (7, 25)

Until apple pomace free of DDT or other toxic insecticide residues is available, it cannot be recommended for feeding to beef cattle.

During the winter of 1956-57 the feeding value of apple pomace was investigated using 45 yearling heifers and 106 brood cows. Apple pomace had a feeding value approximately equivalent to grass silage for wintering beef cows.

Although no gross toxic effects were observed in the cattle receiving apple pomace in the study described above, DDT used as an orchard insecticide is known to remain as a residue on the apple skins going into pomace. Excessive levels of DDT were found in the internal fat of an apparently healthy heifer which had received apple pomace during the winter of 1957-58. Accordingly, to test DDT accumulation on a systematic basis, six yearling heifers were fed dried apple pomace known to contain 103 ppm DDT in 1959. Samples of internal fat were taken from each animal before, during, and following the apple pomace feeding period of 104 days. A tenfold excess of the permissible legal tolerance of DDT (7 parts per million) accumulated internally with no visible manifestation of toxicity to the cattle. Excessive residues thus attained are slowly dissipated, average residues being 8.6 parts per million when the cattle were slaughtered 566 days after last receiving pomace.

The rise and fall of DDT residue in six yearling heifers' internal fat were determined from studies of periodic omental biopsies.

Insecticides (12)

Optimum timing for treatment with a systemic insecticide for grub control was studied on 130 yearling heifers between August and December 1957. Results indicated that certain systemic insecticides would provide effective control for grubs, if applied at recommended levels, any time between August and December.

Systemic insecticides were applied orally in bolus form in 1957. Effective insecticides have recently been developed for pour-on or spray application.

Rumen Liquor and Gains (29)

Inherent differences in total feed consumption, in digestive ability, and in concentration of certain volatile fatty acids in the rumen were suggested by reports of other workers. Record-of-performance (ROP) bull calves fed individually provided suitable experimental animals for further study of these factors. Therefore, in 1958 and 1959 samples of rumen liquor were obtained from 46 bulls chosen on the basis of their test gains from a group of 87 calves being tested after weaning. Volatile fatty acids (butyric plus higher, proprionic, acetic and total acids) of the rumen were of limited value in predicting individual gain or feed efficiency.

Unpublished Work

Other studies conducted by the Front Royal staff, or in conjunction with personnel of cooperating agencies have not been published. These were felt to have inconclusive results, or are currently incomplete. Future progress reports will contain descriptions of such work when results are considered conclusive.

FUTURE PLANS

The preceding sections of this report describe some of the information obtained since 1950. Plans for work in the near future include more comprehensive analyses of existing data, with emphasis upon estimates of the genetic parameters (i.e., heritabilities and genetic correlations) influencing conformation, growth rate, and other characteristics of economic importance, and upon more detailed studies of the effects of inbreeding.

No major changes in the design or conduct of the present breeding experiment are anticipatedduring the next 5-10 years. Genetic change must, of necessity, be measured between parent and offspring; that is, across generations. And, in terms of cattle generations, each approximately 5 years, the present experiment has been in effect slightly more than one generation. A trend showing genetic change is difficult to measure reliably in this time.

Trends within the selection herds of each breed will be analyzed more critically and completely than has yet been possible. Comparisons of post-weaning performance of bull calves from lines developed at Front Royal with that of bull calves purchased at weaning from outside breeders will provide an indication of the changes in breeders' herds relative to those in the Front Royal selection herds. A majority of bulls chosen for use in the type selection herds has been breeders' calves purchased at weaning, doubtless the result of many generations of selection by breeders for improved conformation. But, in recent years, it has been increasingly difficult to purchase calves whose growth rates exceed those of calves born and raised at Front Royal, most frequently coming from the growth herds themselves. Persistence or change in this pattern will be of more than academic interest.

The organization of a systematic cooperative testing program for the evaluation of inbred lines will be necessary in the near future. Inbreeding levels in most inbred lines are still relatively low (less than 25%), and the present testing program conducted with State correctional institutions has been with Herefords only, where inbreeding levels are lowest of the three breeds being studied. It is therefore hoped that a similar cooperative testing program may be arranged for this purpose with owners of purebred or grade Angus or Shorthorn cows.

Congenital deformities have thus far been rare, although two separate anomalies occurred in the 1962 calf crop. Further investigation of these or other abnormalities will be considered as they arise, since careful study of such conditions leads to a better understanding of normal growth and development.

Cooperative projects requiring new or additional work with the experimental cattle at Front Royal have been, and will continue to be considered as circumstances permit. Projects with animals of other species (e.g., sheep, swine, or laboratory animals) have been suggested for study at the station. Each proposal of new or additional work is reviewed by the Front Royal staff to determine whether its requirements for experimental animals, facilities, and personnel are compatible, regardless of cost, with those of the work already in progress. Proposals believed not to deter the operation of the current research program are then critically examined by the project leaders before being forwarded with suggestions for appropriate administrative action by the two cooperating agencies.

The function of a research program is to provide new and, hopefully, useful information. Much of the information contained in this report is new, most is believed useful. Future plans for the Front Royal station are to provide more of the same.

APPENDIX I. ANGUS SIRES USED IN BREEDING HERDS, 1949-1962 INCLUSIVE

Line No.	Name & Kind of Herd	YEAR USED													
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
A-1	Eileenmere (Inbred)		59	59	59 171	59 171 161 870	59 917	59 870	59 870	59	59	1166	1166	8184 0198	8184 1575
A-2	Rock Delus (Inbred)				057	057	057		057	057	057	057	057	057 0218	0218
A-3	Elkton (Inbred)				420	420	420	420	420	420	420	420	8150	8150	1552
A-4	Blackwood Bandy (Inbred)						890	890	890	890	890	890	890	0210	0210
A-7	Type Selection						940	1019	1081	1165	1349 1376	1349 8184	8184 9811	9811 0808	0808 1803
A-8	Growth Selection						960	1046	1093	1209	1293 1390	8044	8044 9802	9802 0201	0201 1575
A-9	Test	44	66 19 H219 699	8 66 19 30	8 140 040 200	1162	1162	917 150	145 1133	150 0115	8802				8150

APPENDIX II . SHORTHORN SIRES USED IN BREEDING HERDS, 1949-1962 INCLUSIVE

Line No.	Name & Kind of Herd	YEAR USED													
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
S-1	Statesman (Inbred)		552	552	868	885	885	885	885	885	885	885	885	885 0211	885
S-2	Lord Rothes (Inbred)		671	663	663	663	663	663	1176	1176	1176	1392	1392	1392 8290	1392
S-3	Grassdale Leader (Inbred)		T-44	T-44	T-44	T-44	T-44	T-44	T-44 1118	988	Dropped				
S-4	Britomac (Inbred)							B287	B287	B287	B287	B287	B287	B287 9158	9158
S-5	Prince Eric (Inbred)					114	114	114	114	114	114	114	114	114 0189	114
S-7	Type Selection		440	794	114	B287	969	1049	1119	1255	1255 1443	1443 8848	8852 9807	9807 0815	0815 1814
S-8	Growth Selection		552	116	834	940	1009	1060	1174	D-29	1463 1465	1463 8158	8158 9805	9805 0076	0076 1549
S-9	Test	663 671 593 440 492 463	03 727 93	03 021 100	100 116 5166	908	988 940		K-86	1009					

APPENDIX III. HEREFORD SIRES USED IN BREEDING HERDS, 1949-1962 INCLUSIVE

Line No.	Name & Kind of Herd	YEAR USED													
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
H-2	Perfect Domino (Inbred)						R322		R322	R322	R322	R322	9157	R322 0125	0125
H-3	Rollo (Inbred)							373	373	373	373	373	373	373 0025	0079
H-4	McHenry (Inbred)										8801	8801	8801	8801	0069
H-5	Dominion Silver (Inbred)													0811	0811
H-6	Index Selection													0059	1806
H-7	Type Selection													0812	1560
H-8	Growth Selection													0079	1807
H-9	Test	770 3 552 12	552 713 859 840	3141 31 52 023 06 M24 708	31 52 023 06 M24 441 456	31 52 023 441 869 863 V68	31 52 357 202 R26 R310	31 52 1444 357 863 R26 R82 546 1082	863 R26 P417 153	R12 R26 R82 675 828	R82 8803	8803 361	806 9079		

APPENDIX IV. ANGUS CALF PERFORMANCE FROM BIRTH TO WEANING BY SIRES AND LINES, 1950-61.

Name and Kind of Herd	Calf Crop Year	Sire's Ear Tag	Sire's Name	Sire's Reg. No.	All Calves: Inbreeding Coefficient Sire	Dam	Calf	No. Born Alive & dead	% Born alive	Birth to Weaning Data[a]: Birth wt.	Midsummer Data: Wt.[b]	ADG	Type	Weaning Data: ADG	Type	ADG Mid-summer to Wean.
Eileenmere (Inbred)	1951-59	59-A1	KB Eileenmere 21	1103554	.06	.02	.08	85	92.9	61.5	283	1.85	11.5	1.81	12.0	1.77
	1953-54	171-A1	TFB Eileenmere of FR 4	1403408	0	.02	.01	6	100.0	60.2	237	1.48	10.2	1.58	10.6	1.91
	1954	161-A1	M Eileenmere 2	1552436	0	.03	0	8	100.0	66.7	261	1.62	9.9	1.59	10.4	1.58
	1954-57	870-A1	Eileenmere of FR 5	1560457	0	.01	.04	32	87.5	68.6	283	1.79	10.0	1.78	11.0	1.84
	1955	917-A1	Royal Eileenmere of FR	1704043	0	.02	.08	15	93.3	52.0	248	1.63	11.5	1.63	12.1	1.69
	1960-61	1166-A1	FR Eileenmere 1166	2343089	.27	.13	.24	31	90.3	63.9	292	1.90	11.1	1.89	11.4	1.93
					.06	.04	.09	177	92.1	62.6	278	1.80	11.0	1.78	11.6	1.80
Rock Delus (Inbred)	1953-61	057-A2	Rock Delus	1404534	0	.02	.13	113	97.3	57.8	258	1.67	10.7	1.66	11.4	1.69
Elkton (Inbred)	1953-60	420-A3	Blkcp. Stamp of Elkton 2	1304552	0	.02	.04	102	86.3	61.5	258	1.64	10.5	1.66	11.1	1.72
	1961	8150-A3	FR Blackcap Stamp 8150	2721336	.25	0	.24	4	100.0	56.1	247	1.59	9.7	1.61	11.5	1.71
					.12	.02	.04	106	86.8	61.3	258	1.64	10.5	1.66	11.1	1.72
Blackwood Bandy (Inbred)	1955-61	890-A4	Blackwood Bandy of FR 4	1560476	0	.01	.08	115	90.4	63.4	258	1.62	10.3	1.63	10.8	1.65
Type Selection	1955	940-A7	Eric of FR 2	1704065	0	.01	.01	11	90.9	54.7	241	1.56	11.1	1.58	11.3	1.63
	1956	1019-A7	Sir Eileenmere of FR	1859391	0	.01	.05	13	100.0	59.4	253	1.61	11.6	1.66	11.1	1.74
	1957	1081-A7	FR Wintonian Lad 1081	2131005	0	0	.03	14	85.7	57.8	259	1.67	11.2	1.62	12.8	1.57
	1958	1165-A7	FR Wintonian Lad 1165	2343081	0	0	.02	18	100.0	59.8	276	1.80	11.5	1.79	12.5	1.72
	1959-60	1349-A7	FR Wintonian T 1349	2500165	.09	0	.05	24	79.2	58.6	237	1.49	10.2	1.65	11.2	1.86
	1959	1376-A7	FR Wintonian T 1376	2500160	0	.01	.07	11	90.9	58.7	272	1.78	11.6	1.73	12.3	1.62
	1960-61	8184-A7	FR Mr. Eileenmere 8184	2721332	.27	0	.06	13	100.0	60.1	276	1.80	12.0	1.78	12.2	1.72
	1961	9811-A7	Eileenmere Blackcap (Wampler)	2893972	0	.01	0	2	100.0	59.2	222	1.36	12.0	1.71	11.3	2.37
					.04	0	.04	106	91.5	58.6	257	1.66	11.3	1.69	11.9	1.73

Growth Selection	1955	960-A8	Royal Barca of FR 6	1704083	0	.01	0	10	90.0	59.1	259	1.67	10.7	1.63	11.3	1.59
	1956	1046-A8	Sir Eileenmere of FR 4	1859382	0	0	.08	7	100.0	65.6	284	1.82	11.2	1.81	11.4	1.85
	1957	1093-A8	FR Black Eric 1093	2105500	0	.01	.01	14	100.0	64.2	268	1.70	11.3	1.68	12.1	1.63
	1958	1209-A8	FR Blackcap Stamp 1209	1304552	.02	.01	0	11	100.0	64.3	288	1.86	11.4	1.85	11.6	1.75
	1959	1293-A8	FR Blackcap Stamp 1293	2500104	0	.01	.03	11	90.9	60.2	292	1.93	11.3	1.76	10.8	1.63
	1959	1390-A8	FR Eileenmere 1390	2500117	.13	.02	.03	14	78.6	62.6	252	1.58	10.0	1.66	10.2	1.67
	1960-61	8044-A8	FR Blackcap Stamp 8044	2721334	0	.01	.03	32	90.6	66.8	284	1.81	11.2	1.83	11.9	1.81
	1961	9802-A8	Mighty of Wye	2839556	0	0	0	8	87.5	67.0	277	1.75	12.0	1.77	11.3	1.78
					.02	.01	.02	107	91.6	64.2	276	1.77	11.1	1.76	11.5	1.73
Test	1950	HG44-A9	Highlands General 44	944180	0	.03	.01	27	96.3	57.0	268	1.76	9.6	1.75	10.8	1.72
	1951-52	66-A9	Marshall Epponian 2	1204347	.03	.02	0	13	92.3	64.2	287	1.86	10.3	1.80	11.3	1.77
	1951	H219-A9	Highlands Burgess 11	1191564	0	0	.01	8	100.0	69.6	292	1.86	10.5	1.72	11.2	1.55
	1951-52	19-A9	Staunton Hill Colonel 2	1164284	0	.02	.02	27	96.3	61.3	294	1.94	11.3	1.83	11.5	1.72
	1951	699-A9	Amandale Bandolier 24	1267656	0	0	0	1	100.0	77.8	266	1.57	11.5	1.98	10.2	3.06
	1952	30-A9	Blkwd. Bandy of Amandale	1267658	.12	.04	.01	9	100.0	58.7	280	1.84	11.5	1.75	12.0	1.67
	1952-53	IRS8-A9	Ellerslie Envious 18	1138008	.16	0	0	11	100.0	60.0	260	1.66	10.0	1.80	11.2	1.98
	1953	140-A9	Gay Barca A P	1303556	0	.03	0	26	96.2	57.7	281	1.86	10.3	1.82	10.7	1.75
	1953	040-A9	VPI Eric	1281218	0	0	0	10	100.0	53.3	264	1.75	11.9	1.75	11.9	1.81
	1953	200-A9	VPI Envious 200	1406205	0	0	.03	4	75.0	57.9	233	1.46	12.4	1.54	12.8	1.69
	1954	1162-A9	Prince Bandolier UF 2	1611466	0	0	0	17	100.0	55.1	252	1.64	9.7	1.56	10.5	1.45
	1956-58	150-A9	Cornwell Bandolier 150	2075471	0	.01	0	45	91.1	63.4	272	1.73	11.3	1.75	11.8	1.79
	1957	145-A9	Barry Boy A	2169356	0	.01	0	19	100.0	57.9	238	1.50	11.2	1.49	12.4	1.47
	1957	1133-A9	FR Rock Delus 1133	2105485	0	.01	0	14	100.0	56.3	243	1.56	10.0	1.57	11.1	1.56
	1958	0115-A9	Eileen. 22 of Amandale	2197074	0	.01	0	24	91.7	59.8	272	1.77	11.3	1.76	11.9	1.75
	1959	8802-A9	Gracious Bardomere	2511413	0	.01	0	12	91.7	63.1	270	1.72	10.4	1.80	12.1	1.89
	1950-61	A9	(Unknown)		...	...	...	11	90.9	65.6	289	1.86	10.8	1.84	11.8	1.85
					.02	.01	0	278	95.3	59.9	269	1.74	10.8	1.72	11.5	1.70
			Angus Average		.03	.02	.06	1102	92.7	61.1	265	1.70	10.8	1.70	11.4	1.72

[a]Results from calves with complete data through weaning; 785 Angus, 853 Shorthorn, and 802 Hereford.

[b]Adjusted to 120 days of age.

APPENDIX V. SHORTHORN CALF PERFORMANCE FROM BIRTH TO WEANING BY SIRES AND LINES, 1950-61.

Name and Kind of Herd	Calf Crop Year	Sire's Ear Tag	Sire's Name	Sire's Reg. No.	All Calves: Inbreeding Coefficient Sire	Dam	Calf	No. Born Alive & dead	% Born alive	Birth to Weaning Data[a]: Birth wt.	Midsummer Data: Wt[b]	Midsummer Data: ADG	Midsummer Data: Type	Weaning Data: ADG	Weaning Data: Type	ADG Mid-summer to Wean.
Statesman (Inbred)	1951-52	552-S1	Waverley's Statesman	2291825	.19	.09	.25	13	84.6	70.3	239	1.41	9.1	1.33	8.6	1.27
	1953	868-S1	B-P Statesman of FR 4	2640698	.08	.08	.16	11	81.8	64.4	227	1.35	7.8	1.32	8.5	1.23
	1954-61	885-S1	C Statesman of FR 4	2692092	.20	.14	.30	92	87.0	70.3	253	1.53	9.4	1.50	10.0	1.43
					.16	.13	.24	116	86.2	69.7	249	1.49	9.2	1.46	9.7	1.39
Lord Rothes (Inbred)	1951	671-S2	Baron Justice	2469085	.17	.11	.18	7	100.0	67.2	260	1.60	10.1	1.58	10.5	1.50
	1952-56	663-S2	Baron Kinsman	2458011	.16	.12	.19	49	89.8	70.6	251	1.50	10.2	1.46	10.4	1.34
	1957-59	1176-S2	FR Baron B 1176	2847272	.17	.20	.31	30	86.7	70.4	255	1.54	10.6	1.53	11.1	1.45
	1960-61	1392-S2	FR Baron B 1392	2930181	.30	.21	.30	14	100.0	71.7	278	1.72	11.0	1.60	11.8	1.43
					.20	.16	.24	100	91.0	70.2	257	1.56	10.4	1.52	10.8	1.40
Grassdale Leader (Inbred)	1951-56	T44-S3	Grassdale Leader	2537106	0	.08	.02	106	90.6	64.3	241	1.47	9.7	1.45	10.5	1.40
	1957	1118-S3	FR Lord Leader 1188	2847286	.03	0	.06	7	57.1	59.4	210	1.26	10.0	1.59	11.6	1.95
	1958	988-S3	Grassdale Leader of FR13	2747190	0	0	.12	3	66.7	....	...	....	....	....	....	....
					.01	.09	.02	116	87.9	64.1	239	1.46	9.7	1.46	10.6	1.43
Britomac (Inbred)	1956-61	B287-S4	Britomac Prince Command	2686140	0	.04	.03	82	90.2	66.0	254	1.57	10.8	1.50	11.5	1.36
Prince Eric (Inbred)	1954-61	114-S5	Prince Eric	2655343	0	.05	.07	131	92.4	69.0	248	1.49	10.4	1.47	10.8	1.42
Type Selection	1951	440-S7	Waverley's Bard	2142653	.01	.07	.14	10	90.0	72.5	218	1.21	8.3	1.20	9.4	1.17
	1952	794-S7	FR Waverley 12	2585727	.11	.11	.13	10	90.0	72.0	226	1.28	9.5	1.33	9.7	1.39
	1953	114-S7	Prince Eric	2655343	0	.09	0	7	100.0	72.8	263	1.59	9.9	1.55	11.2	1.48
	1954	B287-S7	Britomac Prince Command	2686140	0	.04	0	8	87.5	63.4	237	1.45	11.0	1.46	12.0	1.45
	1955	969-S7	Grassdale Leader of FR 8	2745824	0	.12	.06	14	85.7	66.2	268	1.68	10.5	1.64	11.6	1.54
	1956	1049-S7	T Pr. Command of FR 3	2787695	0	.08	0	15	100.0	68.0	257	1.57	11.1	1.46	11.5	1.25
	1957	1119-S7	FR Lord Leader 1119	2847287	0	.07	.04	17	88.2	69.1	249	1.50	10.5	1.61	11.6	1.71
	1958-59	1255-S7	FR Prince Command 1255	2885343	0	.03	.02	20	85.0	68.9	248	1.49	9.8	1.42	10.7	1.26
	1959-60	1443-S7	FR Leader T 1443	2930190	0	.02	.06	21	71.4	67.5	254	1.56	10.2	1.51	10.6	1.40
	1960	8848-S7	Tutira Valiant	2985434	0	0	0	2	50.0	71.3	323	2.10	11.9	1.51	8.7	.72
	1961	8852-S7	Tutira Dazzler	2985438	0	.02	0	9	77.8	68.9	261	1.60	10.0	1.52	10.3	1.23
	1961	9807-S7	Ransom's Banker 64(Todd)	2998860	.03	.02	0	4	100.0	64.0	239	1.46	10.2	1.46	10.4	1.46
					.01	.06	.04	137	86.1	68.7	250	1.51	10.2	1.48	10.9	1.39

Growth Selection	1951	552-S8	Waverley's Statesman	2291825	.19	.10	.14	8	87.5	72.0	278	1.72	10.0	1.69	11.0	1.68
	1952	116-S8	Ransom Mercury	2604715	0	.11	0	13	100.0	71.0	265	1.61	10.4	1.49	10.8	1.29
	1953	834-S8	T Royal Leader of FR 9	2644850	0	.12	.06	7	85.7	64.7	254	1.58	10.2	1.53	10.7	1.32
	1954	940-S8	Grassdale Leader of FR 7	2692104	0	.12	.06	8	100.0	75.0	255	1.50	10.6	1.49	11.1	1.48
	1955	1009-S8	Ransom Clipper of FR 6	2747191	0	.07	.05	20	95.0	68.0	259	1.59	10.0	1.61	11.1	1.60
	1956	1060-S8	Grassdale Leader of FR25	2787673	0	.05	.06	22	86.4	66.4	248	1.52	10.2	1.46	10.7	1.33
	1957	1174-S8	FR Clipper G 1174	2847276	0	.04	.05	15	80.0	70.2	259	1.57	10.5	1.73	11.2	1.86
	1958	D29-S8	VPI Wonder 2D	2890649	0	.03	0	18	83.3	73.7	253	1.49	9.6	1.45	9.9	1.32
	1959-60	1463-S8	FR Clipper G 1463	2932208	.04	.04	.08	14	92.9	75.0	265	1.58	9.1	1.61	9.8	1.62
	1959	1465-S8	FR Clipper G	2932204	.04	.03	.09	11	81.8	71.3	260	1.57	9.6	1.63	10.9	1.67
	1960-61	8158-S8	FR Ransom Clipper 8158	2977668	.03	.02	.06	21	85.7	70.3	250	1.50	9.1	1.51	9.9	1.44
	1961	9805-S8	HiHo Gambler Twenty-One	3011086	0	.05	0	7	85.7	69.3	244	1.46	10.0	1.45	11.1	1.45
					.02	.05	.05	164	88.4	70.4	257	1.55	9.9	1.55	10.6	1.50
Test	1950	440-S9	Waverley's Bard	2142653	.01	.10	.14	3	100.0	70.7	234	1.36	10.2	1.41	11.1	1.41
	1950	463-S9	Waverley's Warden	2170516	.03	.06	.10	15	100.0	67.7	244	1.47	10.6	1.50	10.7	1.50
	1950	492-S9	Baron's Augustus	2214826	.01	.04	.13	13	84.6	76.3	260	1.53	11.2	1.51	11.5	1.45
	1950	593-S9	Waverley's Landsman	2359111	.11	.13	.14	13	92.3	66.3	236	1.41	9.6	1.38	10.1	1.31
	1950	663-S9	Baron Kinsman	2458011	.16	.10	.10	13	84.6	69.8	280	1.75	11.0	1.69	12.0	1.52
	1950	671-S9	Baron Justice	2469085	.17	.09	.11	13	84.6	67.2	260	1.60	10.1	1.53	11.1	1.45
	1951	727-S9	Waverley's Crown	2534224	.10	.09	.12	9	100.0	66.6	228	1.34	9.4	1.36	10.4	1.42
	1951	FW3D-S9	Scotsdale Drummer	2586226	0	.10	0	2	100.0	64.0	211	1.22	7.3	1.19	8.7	1.18
	1951-52	03-S9	Hi Ho Regal Leader	2543375	0	.08	0	26	84.6	69.5	241	1.43	9.5	1.46	10.2	1.48
	1952	021-S9	Tuscawilla Mercury 16	2584370	0	.11	0	14	92.9	69.3	252	1.52	9.2	1.45	9.6	1.32
	1952-53	100-S9	Woodshade Banner Leader	2403980	0	0	0	5	80.0	73.2	281	1.74	10.3	1.63	10.4	1.45
	1953	116-S9	Ransom Mercury	2604715	0	.10	0	17	82.4	71.0	286	1.79	10.9	1.69	11.8	1.54
	1953	5166-S9	K F Bounce 6	2646719	.03	0	0	3	100.0	71.7	271	1.66	12.7	1.67	10.6	1.72
	1954	908-S9	Grassdale Leader of FR 4	2692101	0	.12	.07	14	85.7	64.8	221	1.30	9.4	1.31	10.4	1.34
	1955	988-S9	Grassdale Leader of FR13	2747190	0	0	.05	17	100.0	66.0	265	1.66	10.1	1.65	11.0	1.61
	1955	940-S9	Grassdale Leader of FR 7	2692104	0	.10	.07	12	100.0	68.8	258	1.58	9.8	1.60	11.0	1.58
	1957	K86-S9	Archwood Commander	2835735	0	.04	0	9	100.0	65.7	239	1.44	9.6	1.49	10.9	1.52
	1958	1009-S9	Ransom Clipper of FR 6	2747191	0	.07	.02	31	87.1	71.8	251	1.49	9.8	1.53	10.5	1.58
	1950-61	S9	(Unknown)		....	....	....	1	0	....	....	....	....	....	....	....
					.03	.08	.05	230	90.0	69.0	252	1.53	10.1	1.52	10.8	1.48
			Shorthorn Average		.04	.08	.09	1076	89.0	68.4	251	1.52	10.1	1.50	10.7	1.42

[a]Results from calves with complete data through weaning; 785 Angus, 853 Shorthorn, and 802 Hereford.

[b]Adjusted to 120 days of age.

APPENDIX VI. HEREFORD CALF PERFORMANCE FROM BIRTH TO WEANING BY SIRES AND LINES, 1950-61.

Name and Kind of Herd	Calf Crop Year	Sire's Ear Tag	Sire's Name	Sire's Reg. No.	All Calves: Inbreeding Coefficient Sire	Dam	Calf	No. Born Alive & dead	% Born alive	Birth to Weaning Data[a]: Birth wt.	Midsummer Data: Wt.[b]	ADG	Type	Weaning Data: ADG	Type	ADG Mid-summer to Wean.
Perfect Domino (Inbred)	1955-60	R322-H2	RF Perfect Domino	P7842586	0	.01	.02	98	95.9	67.5	266	1.66	10.9	1.64	11.4	1.60
	1961	9157-H2	FR Perfect Dom 9157	10979580	.25	0	.20	2	100.0	67.4	259	1.60	10.0	1.56	9.6	1.49
					.12	.01	.02	100	96.0	67.5	266	1.66	10.9	1.63	11.3	1.60
Rollo (Inbred)	1956-61	373-H3	Coastal Beau Rollo 9	P6741418	0	0	.02	107	93.5	68.9	279	1.75	10.1	1.69	10.5	1.62
McHenry (Inbred)	1959-61	8801-H4	NPC McHenry 6497	9632052	.02	.01	0	103	94.2	66.7	270	1.70	11.1	1.64	11.6	1.57
Test	1950	3-H9	Rupert Domino I	4308086	0	0	0	47	95.7	68.0	280	1.77	10.4	1.62	11.5	1.52
	1950	770-H9	Star Domino S18	3579334	0	0	0	5	100.0	64.4	279	1.79	10.8	1.27	11.8	1.14
	1950-51	552-H9	Noe's Rupert 31	4448673	0	0	0	6	100.0	66.4	270	1.70	9.2	1.51	10.2	1.38
	1950	12-H9	Riley Domino	5412123	0	0	0	1	100.0	80.0	318	1.98	10.3	1.84	11.5	1.44
	1951	859-H9	Battle Bocaldo 108	5679993	0	0	0	34	94.1	69.8	265	1.63	9.6	1.50	10.1	1.27
	1951	713-H9	OB Domino 98A	5539645	0	.01	0	32	93.8	64.4	258	1.61	11.0	1.44	11.4	1.19
	1951	840-H9	RF Choice Domino E9	5668954	0	0	0	14	92.9	61.0	258	1.64	10.4	1.41	10.3	1.00
	1952-56	31-H9	B Larry Domino 2	4211041	0	0	.03	130	96.2	65.1	227	1.35	10.4	1.38	10.6	1.47
	1952-54	023-H9	G Prince Mixer 14	6189941	0	0	0	59	91.5	65.0	246	1.50	10.5	1.46	10.1	1.41
	1952-53	M24-H9	Read's Baca Duke I	6316644	0	...	...	34	94.1	77.5	235	1.31	7.6	1.47	9.3	1.71
	1952-56	52-H9	CMF Royal Domino 27	6139152	0	0	.02	81	96.3	66.4	238	1.43	10.4	1.44	10.2	1.43
	1952-53	06-H9	Kinloch Adventure 50	6229230	0	0	0	32	96.9	67.2	246	1.49	9.6	1.46	9.9	1.32
	1952	3141-H9	M Royal Domino	3273744	0	0	0	1	0	....	...	....	....	....	....	....
	1952	708-H9	VVB Helmsman	5366996	0	0	0	1	100.0	....	...	....	....	....	....	....
	1953-54	441-H9	Colo Domino M 2	6642061	0	0	0	28	96.4	65.8	230	1.37	10.0	1.41	9.9	1.52
	1953	R456-H9	Roose Domino 9	6659904	0	0	0	5	100.0	62.3	213	1.26	10.6	1.38	11.0	1.55
	1954	869-H9	Larry Domino of FR 7	7225621	0	0	0	5	100.0	63.5	231	1.40	10.8	1.48	11.6	1.66
	1954-57	863-H9	Larry Domino of FR 5	7225619	0	0	.06	30	96.7	67.1	257	1.58	10.3	1.57	10.3	1.58
	1954	V68-H9	Gordon's Dale Chief 48	P7314603	.12	0	0	10	90.0	64.6	252	1.56	10.1	1.68	10.4	1.89
	1955-58	R26-H9	Capitan Domino 25	7153191	0	0	.02	87	92.0	66.4	250	1.53	10.1	1.50	10.6	1.45
	1955	R310-H9	RF Perfect Domino 57	P7815783	0	0	0	12	91.7	72.2	268	1.63	10.7	1.66	11.6	1.70
	1955-56	357-H9	CMF Flashy Prcps. 4	7772538	0	0	0	7	100.0	71.4	272	1.67	10.7	1.69	10.7	1.69
	1956	1444-H9	LL Domino 116	6862458	0	0	0	19	100.0	62.9	297	1.89	10.0	1.77	10.2	1.64
	1956-59	R82-H9	S Hillcrest Domino 5	8356794	0	.02	0	33	97.0	65.5	270	1.71	11.3	1.67	11.7	1.59
	1956	546-H9	PF Ideal Mixer 15	8437628	0	0	0	15	93.3	66.2	262	1.63	11.9	1.61	11.8	1.61
	1957	153-H9	SSF Colorado 2	8934155	0	0	0	11	100.0	63.2	275	1.76	11.1	1.73	11.7	1.71
	1957	P417-H9	PF Bojac Advance 16	P8927353	0	0	0	10	100.0	63.7	278	1.78	10.3	1.69	10.3	1.60
	1958	R12-H9	Russleen Oliveboy	6549573	0	0	0	2	100.0	44.0	310	2.22	13.5	1.97	13.1	1.69
	1959-60	8803-H9	SF Real Prince A105	8762928	.08	.01	0	19	94.7	64.9	281	1.80	11.8	1.77	12.3	1.56
	1960	361-H9	MH Lionheart 193	9190510	0	0	0	4	100.0	70.3	253	1.53	10.8	1.57	11.4	1.60
	1961	0806-H9	Battle Intense 263	9315144	.05	0	0	6	100.0	74.3	282	1.73	11.8	1.77	12.5	1.95
	1950-61		(Unknown)		...	...	...	6	83.3	65.6	246	1.50	10.2	1.72	10.6	2.08
					.01	0	.01	786	95.0	66.3	248	1.51	10.4	1.51	10.6	1.51
			Hereford Average		.01	0	.01	1096	94.9	67.4	267	1.66	10.6	1.62	11.0	1.58
			All Purebred		...	...	...	3174	92.2	....	...	....	....	....	....	....
			Crossbred		...	...	...	168	94.0	....	...	....	....	....	....	....
			Herd Total		...	...	...	3342	92.3	....	...	....	....	....	....	....

[a] Results from calves with complete data through weaning; 785 Angus, 853 Shorthorn, and 802 Hereford.

[b] Adjusted to 120 days of age.

APPENDIX VII. 'BULLS' POSTWEANING PERFORMANCE, 1950-1961 INCLUSIVE

Line No. and Name	No. of Calves on Test	Age of Dam	F of Calf	Begin. Test Weight	Ending Test Weight	Test ADG	Yearling Type Score
ANGUS							
A-1 Eileenmere	35	5.1	.07	495	891	2.36	11.3
A-2 Rock Delus	15	3.7	.15	476	856	2.26	11.7
A-3 Elkton	17	5.7	.05	510	915	2.41	11.4
A-4 Blackwood Bandy	16	5.6	.12	473	851	2.25	11.1
Foundation and inbred ave.	83	5.0	.10	488	878	2.32	11.4
A-7 Type selection	15	4.8	.04	493	886	2.34	12.2
A-8 Growth selection	17	5.7	.02	512	922	2.44	11.3
A-9 Test	32	6.4	0	496	851	2.11	10.9
Breed average	147	5.5	.04	497	884	2.30	11.4
SHORTHORN							
S-1 Statesman	19	6.9	.24	462	878	2.49	10.1
S-2 Lord Rothes	18	6.9	.23	435	849	2.47	11.5
S-3 Grassdale Leader	16	5.5	.02	438	840	2.40	11.9
S-4 Britomac	6	7.0	.04	460	860	2.38	11.5
S-5 Prince Eric	20	4.6	.09	475	883	2.44	11.1
Foundation and inbred ave.	79	6.2	.12	454	862	2.44	11.2
S-7 Type selection	21	5.5	.02	445	865	2.50	12.2
S-8 Growth selection	19	4.7	.07	450	895	2.65	10.5
S-9 Test	25	4.6	.04	448	849	2.39	10.9
Breed average	144	5.2	.06	449	868	2.50	11.2
HEREFORD							
H-2 Perfect Domino	15	6.9	.04	498	875	2.25	11.4
H-3 Rollo	16	6.3	.03	498	946	2.67	10.8
H-4 McHenry	10	6.7	0	486	902	2.47	12.0
Foundation average	41	6.6	.02	494	908	2.46	11.4
H-9 Test	64	6.3	0	435	776	2.04	10.4
Breed average	105	6.4	.01	464	842	2.25	10.9
CROSSBRED	50	...	...	...	...	....	....
HERD TOTAL	446	...	...	...	...	....	....

APPENDIX VIII. HEIFERS' POSTWEANING PERFORMANCE, 1950-61 INCLUSIVE

Line No. and Name	No. of Calves on Test	Age of Dam	F of Calf	Begin. Test Weight	Ending Test Weight	Test ADG	Yearling Type Score
ANGUS							
A-1 Eileenmere	76	5.0	.10	462	640	1.52	11.4
A-2 Rock Delus	60	4.1	.11	446	630	1.34	12.1
A-3 Elkton	36	6.3	.04	467	655	1.42	11.3
A-4 Blackwood Bandy	43	5.2	.04	478	660	1.37	11.4
Foundation and inbred ave.	215	5.2	.07	463	646	1.41	11.6
A-7 Type selection	29	5.0	.03	449	622	1.22	12.1
A-8 Growth selection	43	4.4	.02	451	644	1.34	11.6
A-9 Test	58	5.3	0	459	624	1.52	11.5
Breed average	345	5.0	.03	456	634	1.37	11.7
SHORTHORN							
S-1 Statesman	41	6.3	.26	423	632	1.63	10.3
S-2 Lord Rothes	41	6.7	.24	414	598	1.62	11.3
S-3 Grassdale Leader	37	5.2	.02	399	588	1.56	11.4
S-4 Britomac	37	6.4	.03	456	618	1.21	10.8
S-5 Prince Eric	44	5.1	.06	410	593	1.30	11.1
Foundation and inbred ave.	200	5.9	.16	420	606	1.46	11.0
S-7 Type selection	48	5.2	.04	417	617	1.61	12.1
S-8 Growth selection	73	5.5	.04	431	650	1.71	11.3
S-9 Test	61	5.6	.08	418	596	1.63	11.6
Breed average	382	5.6	.08	422	617	1.60	11.5
HEREFORD							
H-2 Perfect Domino	41	4.6	.04	394	564	1.16	10.8
H-3 Rollo	40	5.7	.01	428	619	1.36	10.5
H-4 McHenry	34	6.8	.01	425	595	1.18	11.8
Foundation average	115	5.7	.02	416	593	1.23	11.0
H-9 Test	193	6.0	.02	388	567	1.51	10.8
Breed average	308	5.8	.02	402	580	1.37	10.9
HERD TOTAL	1035	...	...	...	...	....	....

APPENDIX IX. STEERS' POSTWEANING PERFORMANCE, 1950-1961 INCLUSIVE

Line No. and Name	No. of Calves on Test	Age of Dam	F of Calf	Begin. Test Weight	Ending Test Weight	Test ADG	Yearling Type Score
ANGUS							
A-1 Eileenmere	8	6.1	.28	502	886	1.96	11.3
A-2 Rock Delus	12	3.8	.26	473	808	1.60	10.6
A-3 Elkton	8	6.1	0	552	896	1.75	10.8
A-4 Blackwood Bandy	14	5.9	.08	509	871	1.79	10.9
Foundation and inbred ave.	42	5.5	.16	509	865	1.78	10.9
A-7 Type selection	19	4.6	.03	479	850	1.77	11.5
A-8 Growth selection	20	4.8	.02	486	868	1.83	11.1
A-9 Test	3	6.7	0	532	907	1.91	10.3
Breed average	84	5.4	.10	505	872	1.80	10.9
SHORTHORN							
S-1 Statesman	19	6.8	.30	436	856	2.07	10.6
S-2 Lord Rothes	13	4.2	.30	398	791	1.91	10.9
S-3 Grassdale Leader	9	7.3	0	445	890	2.27	13.3
S-4 Britomac	11	4.9	.02	450	830	1.85	11.0
S-5 Prince Eric	23	5.2	.08	434	850	2.09	11.6
Foundation and inbred ave.	75	5.7	.14	433	843	2.04	11.5
S-7 Type selection	20	4.2	.05	450	867	1.96	11.9
S-8 Growth selection	27	4.1	.05	444	893	2.25	11.7
S-9 Test	6	5.2	.04	427	886	2.34	13.3
Breed average	128	5.2	.10	438	858	2.09	11.8
HEREFORD							
H-2 Perfect Domino	15	4.9	.02	427	791	1.76	10.9
H-3 Rollo	15	5.0	0	456	910	2.19	10.7
H-4 McHenry	11	5.2	0	443	899	2.07	11.4
Foundation average	41	5.0	.01	442	867	2.01	11.0
H-9 Test	34	5.4	0	487	856	1.87	11.0
Breed average	75	5.1	0	453	864	1.97	11.0
HERD TOTAL	287	...	...	...	...	....	....

APPENDIX X. NUMBERS OF CALVES WITH COMPLETE RECORDS THROUGH WEANING, AND THROUGH POSTWEANING TESTS, 1950-1961 INCLUSIVE

Kind of Herd	Total born (Alive and Dead)	Complete Data Through				
		Weaning	Postweaning (ROP) tests			
			Bull	Heifer	Steer	Total
ANGUS						
Foundation and inbred	511	430	83	215	42	340
Type selection	106	84	15	29	19	63
Growth selection	107	89	17	43	20	80
Test	278	182	32	58	3	93
Total	1002	785	147	345	84	576
SHORTHORN						
Foundation and inbred	545	444	79	200	75	354
Type selection	137	108	21	48	20	89
Growth selection	164	133	19	73	27	119
Test	230	168	25	61	6	92
Total	1076	853	144	382	128	654
HEREFORD						
Foundation	310	280	41	115	41	197
Test	786	552	64	193	34	291
Total	1096	802	105	308	75	488
ALL PUREBRED	3174	2440	396	1035	287	1718
CROSSBRED	168	....	...	....	...	....
HERD TOTAL	3342	....	...	....	...	....

APPENDIX XI. PUBLISHED REPORTS FROM THE FRONT ROYAL STATION

Appearing below is a list of published reports dealing with research conducted entirely, or in part, at the Beef Cattle Research Station, Front Royal, Virginia, since 1950.

1. Priode, B. M. 1950. Differences in performance of potential herd sires. M. S. Thesis, VPI Library, Blacksburg, Virginia.

2. Burris, M. J. and B. M. Priode. 1955. Permanency of conformation scores placed on beef heifers. J. Animal Sci. 14:1177. (Abstr.).

3. Burris, M. J. and B. M. Priode. 1956. Crossbred dwarfs in beef cattle. J. Heredity 47:245-247.

4. Carter, R. C. 1956. Heritability of gain and grade in beef cattle. Unpublished Ph. D. Thesis. Iowa State University Library, Ames, Iowa.

5. Kincaid, C. M., W. S. Wilkinson, J. C. Taylor, B. M. Priode and M. J. Burris. 1956. Value of certain carbonated crude phospholipids as additives to rations for fattening beef cattle. J. Animal Sci. 15(4):1262-1263. (Abstr.).

6. Wiltbank, J. N., M. J. Burris and B. M. Priode. 1956. Occurrence of estrus and the conception rate in a herd of 450 beef cows bred during a limited breeding season. J. Animal Sci. 15(4):1216-1217. (Abstr.).

7. Burris, M. J. and B. M. Priode. 1957. Value of apple pomace as a roughage for wintering beef cattle. Va. Agr. Exp. Sta. Research Report No. 12.

8. Burris, M. J. and B. M. Priode. 1958. Effect of calving date on subsequent calving performance. J. Animal Sci. 17:527-533.

9. Gaines, J. A., R. C. Carter and C. M. Kincaid. 1958. Heritability of TDN/cwt gain in beef cattle that are full fed. J. Animal Sci. 17:1143. (Abstr.).

10. Kincaid, C. M. and R. C. Carter. 1958. Estimates of genetic and phenotypic parameters in beef cattle. I. Heritability of growth rate estimated from response to sire selection. J. Animal Sci. 17:675-683.

11. Taylor, J. C. 1958. Repeatability of performance in the beef cow. Unpublished M. S. Thesis, VPI Library, Blacksburg, Virginia.

12. Turner, E. C. and J. A. Gaines. 1958. Systemic insecticides for control of cattle grubs in Virginia. J. Econ. Ent. 51:582-585.

13. Burris, M. J. and B. M. Priode. 1959. Various levels of cottonseed phospholipids in drylot. Part 2, Tech. Bull. 139. Va. Agr. Exp. Sta., Blacksburg, Virginia.

14. Carter, R. C. and C. M. Kincaid. 1959. Estimates of genetic and phenotypic parameters in beef cattle. II. Heritability estimates from parent-offspring and half-sib resemblances. J. Animal Sci. 18:323-330.

15. Carter, R. C. and C. M. Kincaid. 1959. Estimates of genetic and phenotypic parameters in beef cattle. III. Genetic and phenotypic correlations among economic characters. J. Animal Sci. 18:331-335.

16. Lehmann, R. P. 1959. A selection index for beef calves at weaning. Unpublished M. S. Thesis, VPI Library, Blacksburg, Virginia.

17. Thornton, J. W. and J. N. Wiltbank. 1959. Breed and sire differences in gestation length of beef cattle. J. Animal Sci. 18:1153. (Abstr.).

18. Bovard, K. P. 1960. Hereditary dwarfism in beef cattle. An. Breed. Abstr. 28:223-237.

19. Flock, D. K. 1960. Linear body measurements and other birth observations on beef calves as predictors of preweaning growth rate and weaning type score. Unpublished M. S. Thesis, VPI Library, Blacksburg, Virginia.

20. Meyerhoeffer, D. C., R. C. Carter and B. M. Priode. 1960. Early selection of beef calves. J. Animal Sci. 19:1222-3. (Abstr.).

21. Meyerhoeffer, D. C. 1960. Effect of age on the accuracy of selection among beef calves for growth rate and type. Unpublished M. S. Thesis, VPI Library, Blacksburg, Virginia.

22. Taylor, J. C., R. C. Carter, C. M. Kincaid, B. M. Priode and J. A. Gaines. 1960. Estimates of genetic and phenotypic parameters in beef cattle. IV. Repeatability of cow performance. J. Animal Sci. 19:700-708.

23. Thornton, J. W. 1960. Estimates of genetic, phenotypic, and environmental parameters of growth in beef heifers. Unpublished M. S. Thesis, VPI Library, Blacksburg, Virginia.

24. Thornton, J. W., J. A. Gaines and C. M. Kincaid. 1960. Estimates of parameters of growth in beef heifers. J. Animal Sci. 19:1228. (Abstr.).

25. Bovard, K. P., B. M. Priode, G. E. Whitmore and A. J. Ackerman. 1961. DDT residues in the internal fat of beef cattle fed contaminated apple pomace. J. Animal Sci. 20:824-826.

26. Bovard, K. P. and B. M. Priode. 1961. Effects of stage of estrus, and other factors, upon conception rate in beef cows bred artificially. Va. J. Sci. n.s. 12(4):150.

27. Flock, D. K., R. C. Carter, J. A. Gaines and B. M. Priode. 1961. Predicting weaning traits from birth observations in beef calves. J. Animal Sci. 20:905-906. (Abstr.).

28. Lehmann, R. P., J. A. Gaines, R. C. Carter, K. P. Bovard and C. M. Kincaid. 1961. Selection indexes for weanling traits in beef calves. J. Animal Sci. 20:53-57.

29. Putnam, P. A., K. P. Bovard and B. M. Priode. 1961. Volatile fatty acids in the rumen liquor of bulls on record of performance tests. J. Animal Sci. 20:198. (Abstr.).

30. Wiltbank, J. N., E. J. Warwick, E. H. Vernon and B. M. Priode. 1961. Factors affecting net calf crop in beef cattle. J. Animal Sci. 20:409-416.

31. Bovard, K. P. and B. M. Priode. 1962. Conception rates in beef cows as affected by inbreeding of fetus, and by age and inbreeding of cows. Paper presented 40th Annual Meeting VAS, May 12, 1962.

32. Flock, D. K., R. C. Carter and B. M. Priode. 1962. Linear body measurements and other birth observations on beef calves as predictors of preweaning growth rate and weaning type score. J. Animal Sci. (in press)

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